THE CONSTRUCTION AND TESTING OF A MACRO-ECONOMETRIC FORECASTING MODEL FOR THE GREEK ECONOMY

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ABSTRACT

This thesis concerns the construction and testing of an annual forecasting econometric model for the Greek economy between 1954 and 1977. The economic structure has been broken down into several subsectors and statistical analysis has been employed to determine the main factors explaining the relationships in each subsector.

The work is divided into ten chapters. After a brief introduction giving the background of the Greek economy in outline, the second chapter describes the statistical procedures employed and some of the problems encountered in econometric work, with their suggested solutions. A detailed description of the factor analysis technique is given, as this technique has been extensively employed in the Two Stage Least Squares (TSLS) and reduced form estimations.

The Chapters 3-9 deal with the particular subsectors of the economy, i.e. consumption expenditure (Chapter 3), the effect of wealth on consumption (Chapter 4), the determination of investment (Chapter 5), employment, taxes (Chapter 6), international transactions (Chapter 7), wages and prices (Chapter 8) and the financial sector (Chapter 9). Each subsector has been examined in the context of economic theory and specific models have been tested to determine functions which explain the relationships in the various subsectors satisfactorily.

In the last chapter all subsectors are brought together to estimate the reduced form of the structure, both as a simultaneous system and blockwise. The technique of factor analysis was employed. Orthogonal and oblique rotation of the factors were used in order to determine their differences, if any, and which one tracks the data better, in simulations within the sample period. The selected reduced form was used to generate forecasts and also to test the properties of some multipliers.

A summary of the results of the whole work is finally given.

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1. INTRODUCTION

The history of the modern Greek state has always been marked by political instability, external and internal upheavals, and the last decades have by no means been an exception. The second world war was followed by a civil war (1944-1949) that left the country in ruins. The next phase of relative stability was interrupted by the seven year military regime (1967-1974).

Before the war Greece was a predominantly agricultural country, with the majority of the population living in rural areas. It was after 1950 that reconstruction and efforts to bring the country to the road of development began. Attempts were made to diversify production and industrialize the economy, but this was a slow process and the figures in various censuses provide an indication of this. Still in 1951, the 47.5% of the population was living in the countryside. In 1961 the figure was reduced to almost 44% and only in 1971 a majority of 53.2% were living in urban centres(1).

The transformation of the economy may be better seen in the share of agricultural and manufacturing production in the gross domestic product (manufacturing production includes electricity, gas and water works. The percentages are calculated from figures at constant 1970 prices given in the national accounts(2)).

	1954	1962	1970	1977
Agricultural production	30	23	18	14
Manufacturing production	12	16	21	24

Another feature of the Greek economy that should be mentioned here is the large share of services in the economic activity, as the following figures show:(3)

	1954	1962	1970	1977
Transportation, communication, trade, banking and insurance	18	20	22	24
The above plus health, educational and miscellaneous services	41	32	33	35

The measures taken for economic development in conjunction with the general economic climate of the Western world resulted in an average of growth of around 6% for the period 1954-1977. A significant characteristic of this development is that it was heavily dependent on imports of capital goods and raw materials necessary in the process of industrialization. This is exemplified by the share of imports to GNP, which was 10.38% for 1954, 16% for 1964 and almost 24% in 1973.

The increase of national product and the resulting higher standards of living meant that imports also increased to satisfy the new demands. To pay for these the country had to take measures to encourage exports. Thus the exports share in GNP from 5.2% in 1954 reached 6.1% in 1969, 8.5% in 1973 and 10.0% in 1977. Measures were also taken to change the composition of exports; whereas primary products constituted 90% of total exports of goods in 1954, they were 64% in 1969 and 45% in 1977. At the same time exports of services were also encouraged and the advantages of the country in tourism and shipping were exploited to a far larger extent. Thus the share of total exports of goods and services was approximately 7% in 1954, 9.5% in 1969 and 14.5% in 1977. Despite all efforts there has been a very large deficit in the balance of international transactions throughout the period as the following figures show:[4] (figures in billion drs at current prices).

	1954	1962	1970	1977
Total exports of goods and services	6.2	12.2	30.0	154.9
Total imports of goods and services	10.5	21.3	55.0	243.3
Balance of goods, services and incomes	-3.4	-6.4	-19.5	-58.1
Net borrowing (after allowing for current transfer (net) and capital transfers)	3.4	-	9.2	25.8

Part of this deficit has been met by transfers and remittances of emmigrants. Between 1954 and 1973 about one million people have gone to work abroad for different lengths of time mainly in Western Europe and especially Germany. The remaining of the deficit is being met by loans, with all known consequences these have had, especially in the last years.

Government plays an important role in the country's economy. It tries to influence economic activities by formulating and implementing development plans. It has always had part of the banking system under its own control and recently this part has been largely extended. In addition the state undertakes investment, and especially in infrastructure. While the government share in equipment investment is approximately 13% in 1970, 19% in 1973 and 11% in 1977, its share in construction investment for the same years is 63%, 61% and 56%. It is worth mentioning here that taxes as a percentage of GNP are low relatively to other Western European countries, as the following example for the year 1974 shows[5]. (In the following table a sample of OECD countries is included.)

The Structure of Taxations, Percentage of GNP 1974

	Total Tax Revenue	Goods and Services	Income and Profits	Social Security
Greece	22.4	8.1	3.8	6.0
Italy	31.9	10.8	6.5	13.3
Spain	18.8	5.1	4.0	8.4
Sweden	44.2	11.9	21.4	8.5
U.K.	35.6	9.6	15.4	6.1
OECD Europe	34.5	10.0	11.1	11.3
" Total	31.0	7.3	12.4	8.0

The financial market is relatively under developed. Most companies are of the family ownership type and very few are large. Consequently there is low activity in trading shares and raising capital in the financial market. The capital market is dominated by the borrowing needs of the government and the public enterprises. The banks are obliged to invest in government paper (bonds and treasury bills). The following table for the years 1968-1972 shows the degree of the private (non-banks) sector involvement in capital markets[6].

Capital Market Issue Activity (in million drs)

	1968	1969	1970	1971	1972
Public sector	3048	2000	2200	3850	4800
Banks	-	6	245	378	3090
Private non-banks	136	172	262	14	110
a. bonds	50	100	73	-	-
b. shares	86	72	189	14	110

Two developments which exerted significant influence on the Greek economy during this period are the oil crisis and Greece's entry to the European Economic Community. The oil crisis of 1974 and its aftermath have resulted in high inflationary pressures with serious implications as the figures below indicate[(7)]. (The annual percentage change of Consumer Price Index.)

1973	1974	1977	1979	1980
16	27	13	19	25

The first agreements in the attempt for Greece to join EEC were made in the early 1960's, when measures began to be taken for an adjustment of the country's economy to the conditions of the community. As Greece became full member in 1981, and some of the terms will only apply as from 1987, it is still too early to assess the consequences.

There are two models of the Greek economy that I know of. These cover the period from 1949 to 1960 (Pavlopoulos P. (1966), A Statistical model for the Greek Economy 1949-1959, and D. Suits (1965), An econometric model for the Greek Economy). There is however always a need for econometric models to cover new developments, apply other techniques, concentrate on specific sectors and analyse the economy at different levels of aggregation.

In this study the different sectors of the economy have been examined within the context of economic theory. The various sectors were finally brought together, combined into an interdependent system. Its reduced from was estimated in order to perform simulations and generate forecasts for a period of four years. Because of the relatively large number of the variables involved the statistical technique of factor analysis has been employed. Orthogonal and oblique rotations of the factors have been applied and the differences of their forecasting power were examined.

FOOTNOTES TO CHAPTER ONE

1. Statistical Yearbook of Greece, 1971 and 1980.

2. National Accounts of Greece, 1958-1975; Provisional National Accounts of Greece, year 1979.

3. National Accounts, as above.

4. National Accounts, as above.

5. OECD Surveys: Greece, 1977.

6. OECD Surveys: Greece, 1971.

7. Monthly Statistical Bulletin of the Bank of Greece, and IMF, International Financial Statistics, various issues.

2. ELEMENTS OF THE THEORY AND APPLICATION OF ECONOMETRICS

2.1 Ordinary Least Squares

As the basis of econometrics is regression analysis the study of the linear multiple regression model is considered the necessary starting point in the understanding, development and elaboration of econometric theory.

In the classical regression model it is assumed that a linear relation exists between Y, the dependent variable, and a set of explanatory variables X_j (j=1,.....k) and the disturbance term u. This relationship can then be written as(1):

2.1.1 $$Y_t = b_1X_{1t} + b_2X_{2t} + \ldots\ldots + b_kX_{kt} + u_t$$
$$t = 1,2,\ldots\ldots,T$$

where T is the number of the sample observations and the variable X_{1t} is a constant, that is X_{1t} is a vector of 1's or in a matrix form

2.1.2 $Y = Xb + u$ where

$$Y = \begin{bmatrix} Y_1 \\ Y_2 \\ \cdot \\ \cdot \\ \cdot \\ Y_t \end{bmatrix} \quad X = \begin{bmatrix} 1 & X_{21} & \cdots & X_{k1} \\ 1 & X_{22} & \cdots & X_{k2} \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ 1 & X_{2T} & \cdots & X_{kT} \end{bmatrix} \quad b = \begin{bmatrix} b_1 \\ b_2 \\ \cdot \\ \cdot \\ \cdot \\ b_k \end{bmatrix} \quad u = \begin{bmatrix} u_1 \\ u_2 \\ \cdot \\ \cdot \\ \cdot \\ u_T \end{bmatrix}$$

The above model (2.1.2) contains k unknown regression parameters $b_1, \ldots . b_k$. Unknown are also the parameters of the distribution of the disturbance term u. The problem then is to obtain estimates of these unknowns.

To estimate the vector of the coefficients b, the following assumptions concerning the way the observations in (2.1.2) are generated should be satisfied:

2.1.3a The matrix X(TXk) of the explanatory variables, is a set of fixed elements. This denotes that in repeated sampling the source of variation in the Y vector is the variation in the disturbance term u.

2.1.3b The rank of the matrix X is equal to $k < T$.

2.1.3c The disturbance term u is a random vector of T components independent of the explanatory variables. The disturbances are uncorrelated, each having zero mean and a constant but finite variance. These assumptions about the disturbance term can be represented:

$E(u) = 0$, $E(uu') = \sigma^2 I_T$ that is $E(u_t u_{t+r}) = 0$ for $r \neq 0$ and $COV(X,u) = 0$

Assuming that $\hat{b}$ is an estimator of b the corresponding vector of T residuals (e) is defined as $e = Y - X\hat{b}$. The ordinary least square estimator (OLS) of $\hat{b}$ is derived by minimizing the sum of squared residuals. Thus the sum of square residuals is defined as:

2.1.4 $$\sum_{t=1}^{T} e_t^2 = e'e = (Y-X\hat{b})'(Y-X\hat{b})$$

or expanding (2.1.4) we get

2.1.5 $$\sum_{t=1}^{T} e_t^2 = e'e = Y'Y-Y'X\hat{b}-\hat{b}'X'Y + \hat{b}X'X\hat{b} = Y'Y - 2\hat{b}X'Y + \hat{b}X'X\hat{b}$$

as $Y'X\hat{b}$ is scalar and equals its transpose $\hat{b}'X'Y$

To find the estimator $\hat{b}$ which corresponds to the minimum of (2.1.5) this equation has to be differentiated with respect to the vector of parameters $\hat{b}$ and the derivatives should be set equal to zero.

Thus differentiating (2.1.5) we derive the set of the k normal equations.

2.1.6 $$\frac{\partial}{\partial b}(e'e) = -2X'Y + 2X'X\hat{b} = 0$$

or

2.1.7 $$X'X\hat{b} = X'Y$$

Taking into consideration assumption (2.1.3b) and premultiplying both sides of (2.1.7) by the inverse of X'X the OLS estimator of $\hat{b}$ is derived(2) as:

2.1.8 $$\hat{b} = (X'X)^{-1}X'Y$$

The above estimator (2.1.8) is unbiased, which can be established by substituting (2.1.2) into (2.1.8)

2.1.9 $\hat{b} = (X'X)^{-1}\ X'[Xb + u] = b + (X'X)^{-1}\ X'u$

Taking expected values of both sides of (2.1.9) we get

$$E(\hat{b}) = E(b) + E\ [(X'X)^{-1}X'u]$$

or because of the assumption (2.1.3a) that the elements of X remain fixed:

$$E(\hat{b}) = b + (X'X)^{-1}\ X'E(u)$$

and since $E(u) = 0$ (assumption 2.1.3c)

2.1.10 $E(\hat{b}) = b$

that is the OLS estimator is unbiased.

The variance-covariance matrix of the estimator $\hat{b}$ is denoted as

2.1.11 $\mathrm{Var}\ (\hat{b}) = E\ [(\hat{b}-b)(\hat{b}-b)']$

and from (2.1.9) we obtain

2.1.12 $(\hat{b}-b) = (X'X)^{-1}X'u$

Substituting (2.1.12) into (2.1.11) results in

$$\begin{aligned}\mathrm{Var}\ (\hat{b}) &= E\ \{[(X'X)^{-1}X'u][(X'X)^{-1}X'u]'\} = \\ &= E\ \{[(X'X)^{-1}X'u][u'X(X'X)^{-1}]\} \\ &= E[(X'X)^{-1}X'uu'X(X'X)^{-1}] = (X'X)^{-1}X'E(uu')X(X'X)^{-1}\end{aligned}$$

Taking into account assumption (2.1.3c) the above expression becomes

$$\mathrm{Var}\ (\hat{b}) = (X'X)^{-1}X'\sigma^2 I_T X(X'X)^{-1}$$

and as σ^2 is a scalar the variance-covariance of $\hat{b}$ is

2.1.13 $\quad Var(\hat{b}) = \sigma^2(X'X)^{-1}$

Thus the variance of $\hat{b}_i$ can be calculated by multiplying the i^{th} element of the principal diagonal of $(X'X)^{-1}$ by s^2, which is an unbiased estimator of σ^2 and is expressed as

2.1.14 $$s^2 = \frac{e'e}{T-k} = \frac{(Y-X\hat{b})'(Y-X\hat{b})}{T-k}$$

where k is the number of explanatory variables and T-k the number of degrees of freedom. By expanding the numerator of (2.1.14) the sum of squared residuals, using (2.1.5) and (2.1.7) becomes:

2.1.15 $$\begin{aligned} e'e &= Y'Y - 2\hat{b}X'Y + \hat{b}'X'X\hat{b} = Y'Y - 2\hat{b}X'Y + \hat{b}'X'Y \\ &= Y'Y - \hat{b}'X'Y \end{aligned}$$

2.2 The Use of Dummy Variables

Many times in empirical work, the situation arises, when the effects of qualitative factors should be incorporated in the estimated model. These qualitative factors may take into consideration the characteristics of the individuals, households and firms, or they may be accounting for temporal (wars, change of political regimes), regional or seasonal effects.

The usefulness of the regression model can be extended to incorporate these effects by including dummy variables in the set of exogenous variables. The dummy variables take the value 1 when the effects of these factors are realised and the value zero otherwise.

Consider the following linear model which satisfies all the assumptions concerning the error term (u_t):

2.2.1 $$Y_t = b_o + b_1X_t + u_t$$

If the above relation has been affected by a qualitative factor, these effects can be introduced into (2.2.1) by including a dummy variable (Z_t). Thus

2.2.2 $$Y_t = b_o + b_1X_t + b_2Z_t + u_t$$

where Z_t equals 1 when its effect is realised and zero otherwise. Taking conditional expectations of (2.2.2) with respect to the variable Z_t we derive

$$E(Y_t|Z_t = 0) = b_o + b_1X_t \text{ and}$$

$$E(Y_t|Z_t = 1) = (b_o + b_2) + b_1X_t$$

That is, in this case the intercept of the above relation changes from b_o ($Z_t = 0$) to ($b_o + b_2$) when the dummy variable takes the value 1. Whether such a change is statistically significant, can be examined by testing the null hypothesis that the coefficient $b_2 = 0$.

This procedure could be also used to test whether the slope of the function (2.2.1) is affected, or whether both the intercept and the slope of this function have been simultaneously affected by the qualitative variable.

The first case is taken into account by including in the equation (2.2.1) the term $(X_t Z_t)$. Hence (2.2.1) becomes

2.2.3 $$Y_t = b_o + b_1 X_t + b_3 (X_t Z_t) + u_t$$

Taking conditional expectations of (2.2.3) with respect to Z_t, it gives

$$E(Y_t | Z_t = 0) = b_o + b_1 X_t$$
$$E(Y_t | Z_t = 1) = b_o + (b_1 + b_3) X_t$$

which shows that when the variable Z_t takes the value 1 the slope of (2.2.3) changes to $(b_1 + b_3)$ while the intercept remains constant.

For the second case the function (2.2.1) changes to

2.2.4 $$Y_t = b_o + b_1 X_t + b_2 Z_t + b_3 (X_t Z_t) + u_t$$

and when the variable $Z_t = 1$ the intercept and the slope of (2.2.4) become $(b_o + b_2)$ and $(b_1 + b_3)$ respectively.

Another possibility is to use a dummy variable to test whether an explanatory variable exerts an assymetric influence on the dependent one. For example, when it is postulated that people adjust more easily their consumption expenditure when their incomes increase than when they decrease.

This assymetric response of the dependent variable (Y_t) to changes in the explanatory variable (X_t) can be handled by including in the equation a dummy variable (D_t) which takes the value 1 when

$X_t \leq X_{t-1}$ and zero otherwise, that is

2.2.5 $$Y_t = b_o + b_1 X_t + b_2 (X_t D_t) + u_t$$

The asymmetric response hypothesis is then tested by examining whether the coefficient b_2 is statistically zero.

To take into account the effects of more than one qualitative factor influencing the dependent variable, more dummy variables can be introduced in the estimated equation. The case can be generalised by considering the interaction effects of the qualitative factors by including in the equation cross-product terms of the dummy variables.

2.3 Generalized Least Squares

The difference between generalised least squares (GLS) and OLS is that the former is less restrictive with respect to the assumptions which the disturbance term u should satisfy. The application of OLS requires that all the disturbance terms should have a constant variance and be uncorrelated (2.1.3c).

For the GLS this assumption is replaced by:

2.3.1 $$E(u) = 0, \ E(uu') = \sigma^2 \Omega, \ COV\ (X,u) = 0$$

where σ^2 is unknown but Ω is a known symmetric positive definite matrix of order T. Thus the variance-covariance of the disturbance term u is known up to a scale factor.

The above assumption (2.3.1) does not require a constant variance σ^2 and uncorrelated u's, but is quite general and allows for different variances (heteroskedasticity) and autocorrelation among the disturbances.

To use the least square method some of the properties of positive definite matrices should be utilised. A positive definite matrix is non-singular, has only positive characteristic roots and positive determinant. Using the diagonalization property the matrix Ω is transformed into a diagonal matrix by pre- and post-multiplication with an orthogonal transformation matrix B. Thus

$$2.3.2 \qquad B'\Omega B = \begin{bmatrix} \lambda_1 & 0 & \cdots & 0 \\ 0 & \lambda_2 & \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ 0 & 0 & \cdots & \lambda_T \end{bmatrix} = \Lambda$$

where the λ_i $(i = 1,2,\ldots,T)$ are the characteristic roots of Ω. As all the characteristic roots are positive the above matrix $B'\ B$ can be transformed into a unity matrix when pre- and postmultiplied by a non-singular diagonal matrix G of the form:

$$2.3.3 \qquad G = \begin{bmatrix} \frac{1}{\sqrt{\lambda_1}} & 0 & \cdots & 0 \\ 0 & \frac{1}{\sqrt{\lambda_2}} & \cdots & 0 \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ 0 & 0 & \cdots & \frac{1}{\sqrt{\lambda_T}} \end{bmatrix}$$

Thus pre- and post-multiplying (2.3.2) by G we obtain

2.3.4 $$G'B'\Omega BG = (BG)'\Omega(BG) = I_T$$

or by denoting $P = G'B'$ (2.3.4) becomes:

2.3.5 $$P\Omega P' = I_T$$

As B and G are non-singular matrices P is also non-singular. Then (2.3.5) can be premultiplied by P^{-1} and postmultiplied by $(P')^{-1}$ and will result in

2.3.6 $$P^{-1}P\ \Omega\ P'(P')^{-1} = P^{-1}I_T(P')^{-1} \quad \text{or}$$

2.3.7 $$\Omega = P^{-1}(P')^{-1} = (P'P)^{-1} \text{ and hence}$$

2.3.8 $$\Omega^{-1} = P'P$$

Thus premultiplying (2.1.2) by the non-singular transformation matrix P gives

2.3.9 $$PY = PXb + Pu$$

The model (2.3.9) can be estimated by OLS as the assumption (2.1.3c) is not affected, because by utilizing (2.3.1) we get

$$E(Puu'P') = \sigma^2 P\Omega P' = \sigma^2 I_T \text{ by } (2.3.5)$$

Denoting by $\hat{b}^*$ the GLS estimates of b we derive analogous estimates to (2.1.8) for $\hat{b}^*$

2.3.10 $\hat{b}^* = [(PX)'PX]^{-1} (PX)'PY = (X'P'PX)^{-1}X'P'PY$

and using (2.3.8) we obtain the GLS estimator denoted by $\hat{b}^*$

2.3.11 $\hat{b}^* = (X'\Omega^{-1}X)^{-1} X'\Omega^{-1}Y$

which is a minimum variance linear unbiased estimator of the parameter vector b.

2.4 Maximum Likelihood Estimation

In deriving the significance tests it was necessary to specify the probability distribution of the disturbance term u and it was assumed that it was normally distributed, that is $u \sim N(0,\sigma^2 I_T)$.

In the case in which the form of the probability distribution of a random variable has been specified the maximum likelihood (ML) method of estimation can be applied.

Suppose that a sample consists of a set of T observations Y_1, Y_2, ... Y_T of a random variable Y. For these observations a joint probability density function is specified which depends on an unknown parameters vector $\theta = (\theta_1,\ldots,\theta_k)$. Then the maximum likelihood estimator of the θ vector, is the values of these parameters which are most likely to have generated the observed sample(3).

The expression for the joint probability density function is called the likelihood function and is denoted by

2.4.1 $L(Y_1,Y_2,..,Y_T; \theta)$

In the case of independently distributed variables, the likelihood function can be written as

2.4.2 $$L(Y_1,Y_2,\ldots.Y_T;\theta) = \prod_{t=1}^{T} p(Y_t;\ \theta)$$

where[4] $p(Y_t;\theta)$ is the probability density function of Y_t and $\prod_{t=1}^{T}$ denotes the product of T factors.

The probability density function of a normal distribution is

$$f(x) = (2\pi\sigma^2)^{-\frac{1}{2}}\ e^{-[\frac{1}{2}(\frac{x-b}{\sigma})^2]}$$

In the case of the linear model

$$Y_t = X_tB + u_t \quad (t = 1,2,\ldots,T)$$

it is assumed that u_t is normally and independently distributed and hence Y_t is independently and normally distributed as well, with mean XB and variance σ^2. Thus the probability density function of Y_t can be written as

2.4.3 $$P(Y) = \frac{1}{(2\pi\sigma^2)^{\frac{1}{2}}}\ \exp^{[-\frac{1}{2\sigma^2}\ (Y-XB)'(Y-XB)]}$$

Hence the likelihood function is

2.4.4 $$L(Y_1,Y_2,\ldots,Y_T;\ b,\sigma^2) = p(Y_1)p(Y_2)\ldots.p(Y_t) =$$

$$= \frac{1}{(2\pi\sigma^2)^{T/2}}\ \exp^{[-\frac{1}{2\sigma^2}\ (Y-XB)'(Y-XB)]}$$

To obtain the ML estimator we have to maximize the likelihood function with respect to the parameters b and σ^2. To do this we have to differentiate the likelihood function with respect to each of these parameters and equate the partial derivatives to zero. In practice the logarithm of the likelihood function is maximized as this is easier to work with. This transformation is permissible because the likelihood function is always non-negative (as a formula for a joint probability distribution) and its logarithm is a monotonic transformation which thus preserves ordering[(5)].

Hence the logarithm of the likelihood function to be maximized is

2.4.5 $$\ell n L\ (b,\sigma^2) = -\frac{T}{2}\ \ell n 2\pi - \frac{T}{2}\ \ell n \sigma^2 - \frac{1}{2\sigma^2}\ (Y-X\hat{b})'(Y-X\hat{b})$$

Differentiating (2.4.5) with respect to b and σ^2 gives

2.4.6 $$\frac{\partial(\ell n L)}{\partial b} = \frac{X'Y-X'X\hat{b}}{\sigma^2} = 0$$

2.4.7 $$\frac{\partial(\ell n L)}{\partial \sigma^2} = -\frac{T}{2\sigma^2} + \frac{1}{2\sigma^4}\ (Y-X\hat{b})'(Y-X\hat{b}) = 0$$

Multiplying through (2.4.7) by $2\sigma^4$ and taking into consideration that $(Y-X\hat{b})$ equals the residuals, equation (2.4.7) gives the maximum likelihood estimator of the variance (σ^2_{ML}) that is

$$\sigma^2_{ML} = \frac{e'e}{T}$$

which is a biased estimator.

From (2.4.6) the maximum likelihood estimator of the parameters vector $(\hat{b}_{ML})$ is derived

$$\hat{b}_{ML} = (X'X)^{-1}X'Y$$

which is identical to OLS estimator for b.

2.5 Violation of Basic Assumption of Least Squares

A. Multicollinearity

By assumption (2.1.3b) of the linear model (2.1.2) it is required that the matrix X will be of full rank (k). This assumption ensures that no explanatory variable is perfectly correlated with any other explanatory variable or with any linear combination of them. The violation of this assumption constitutes the problem of multicollinearity.

When there is an exact linear dependency between some of the explanatory variables, it means that one of the columns of the matrix $(X'X)$ of the OLS estimator of b (2.1.8), is an exact linear function of some of the other columns. In this instance the matrix $(X'X)$ is singular, its inverse cannot be calculated, and as a consequence the vectors of parameters b cannot be estimated. This is the case of perfect multicollinearity. The case of a high degree of multicollinearity is usually encountered, which arises when an explanatory variable is highly correlated with other explanatory variables or with a linear combination of them. The existence of high degree of multicollinearity has serious consequences for the parameters estimates, which in its presence, become imprecise due to the large variances of these estimates, and it is difficult to disentangle the relative influence of the various explanatory variables.

A high degree of multicollinearity indicates that one column in the matrix $(X'X)$ comes close to a linear combination with some of the remaining columns. This fact results in a small value for the determinant of $(X'X)$ with the consequence that the elements of the $(X'X)^{-1}$ matrix and therefore the variance-covariances in (2.1.13) of the estimated coefficients will be large.

Because of the consequences of the existence of high degree of multicollinearity, tests have been constructed to detect its presence.

A general test has been constructed by D. E. Farrar and R. Glauber[6]. They assumed that the matrix X of k explanatory variables has a multivariate normal distribution, and they defined multicollinearity as the departure of the matrix X from orthogonality. When the explanatory variables are standardised the matrix (X'X) contains the simple correlation coefficients between them, and consequently its elements are between +1 and -1. The determinant of the matrix (X'X) will be in the range 0 and 1, that is

2.5.1 $$0 < |X'X| \leq 1$$

A transformation of the determinant of the matrix (X'X) denoted by $\ell n|X'X|$ is distributed approximately as χ^2 with $\frac{1}{2}k(k-1)$ degrees of freedom, thus[7]

2.5.2 $$-[(T-1) - (1/6)(2K+5)]\ell n|X'X| \sim \chi^2_{\frac{1}{2}k(k-1)}$$

Using this approximate χ^2 distribution one can test to what degree the correlation matrix departs from orthogonality. If $|X'X|$ approaches zero the value of the χ^2 expression (2.5.2) increases and we may conclude that the matrix X departs from orthogonality. On the other hand, when $|X'X|$ approaches one, the expression (2.5.2) has a low value and we can deduce that the columns of X are orthonormal. If the test indicates the existence of multicollinearity the next step is to find the variable that causes it. This can be accomplished by calculating the coefficient of determination R_i^2 by regressing each explanatory variable X_i on the remaining explanatory variables in the data matrix. These R_i^2 coefficients can then be tested by using the F test which is distributed with (k-1) and (T-k) degrees of freedom. Thus the following expression is calculated

$$2.5.3 \qquad F_i = \frac{R_i^2}{1 - R_i^2} \cdot \frac{T-k}{T-1}$$

and by inspecting the values of F_i the variables most affected by multicollinearity can be detected(8).

Another procedure for detecting the presence and the degree of multicollinearity based on the singular value decomposition of a matrix has been proposed by D. A. Belsley, E. Kuh and R. E. Welsch(9).

A (T*k) matrix X (usually scaled to have unit column lengths) can be decomposed into

$$2.5.4 \qquad X = UDV'$$

where $U'U = V'V = I_k$ and D is diagonal with non-negative elements μ_j $(j = 1,2,\ldots,k)$ which are called the singular values of X.

The existence of strong linear dependencies among the columns of the matrix X will be indicated by small singular values μ_j. The presence of strong linear dependencies results in ill conditioned matrices for which their inversion creates problems. To define the conditioning of a matrix X, a measure called the condition number of X is employed. The condition number of a matrix X, denoted by CN(X) is then defined as:

2.5.5 $$CN(X) = \frac{\mu_{max}}{\mu_{min}} \geq 1$$

and the larger the condition number the more ill conditioned the matrix X. The degree then of ill conditioning depends on how small is the minimum singular value relative to the maximum singular value.

Defining thus the condition index (CI) as

2.5.6 $$CI_j = \frac{\mu_{max}}{\mu_j} \quad (j = 1,2,\ldots\ldots,k)$$

We can detect the various strong linear dependencies in the matrix X by the number of large condition indexes. That is a singular value which is small relative to μ_{max} has a high condition index. When a condition index is large is a matter to be determined empirically.

The presence of multicollinearity between the regressors as has been already stated, results in the deterioration of the quality of the OLS estimates of the parameters by increasing their variance. By using the singular value decomposition, the variance of each regression coefficient can be broken down into a sum of terms. Each of these terms is associated with a singular value μ_j. The variance-covariance matrix of the OLS estimator is

$$Var(\hat{b}) = \sigma^2(X'X)^{-1}$$

Inserting (2.5.4) in the above expression we obtain

$$2.5.7 \qquad \mathrm{Var}(\hat{b}) = \sigma^2 \,[(UDV')'(UDV)]^{-1} = \sigma^2 VD^{-2}V'$$

using the properties of orthogonal matrices.

The i-th component of the variance-covariance matrix of b is

$$2.5.8 \qquad \mathrm{Var}(\hat{b}_i) = \sigma^2 \sum_{j}^{k} \frac{V_{ij}^2}{\mu_j^2}$$

where the μ_j's are the singular values and V_{ij} is an element of the orthogonal matrix V, the columns of which are the eigenvectors of the matrix $(X'X)$[10].

Defining the i, j-th variance decomposition proportion (VDP) as the proportion of the variance of the i-th regression coefficient associated with the j-th component of the decomposition in (2.5.8) we get

$$2.5.9 \qquad VDP_{ji} = \frac{\phi_{ij}}{\phi_i} \qquad (i,j = 1,2,\ldots,k)$$

where $\phi_{ij} = \dfrac{V_{ij}^2}{\mu_j^2}$ and $\phi_i = \sum_{j=1}^{k} \phi_{ij}$ $(i = 1,2,\ldots,k)$

Thus the information of strong dependencies in the data matrix which is provided by the singular value decomposition is used to assess its effects on the estimates of regression coefficients.

But since two or more variables are required to create a strong linear dependency it should be that two or more variances are unfavourably effected by high variance decomposition proportions associated with a single singular value.

Hence the following two conditions should be fulfilled in order to detect the presence of high degree multicollinearity

(i) a singular value regarded to have a high condition index and which is related to

(ii) high variance decomposition proportions for two or more estimated coefficients variances.

The number of condition indexes considered as large identifies the number of linear relationships among the regressors, while high variance decomposition proportions associated with each large condition index, suggest which variables are involved in these relationships. The magnitude of these proportions together with a large condition index indicates the degree of deterioration of the respective coefficients[11]. But what is a large condition index or a high variance proportion is determined empirically. When the number of linear dependencies has been determined, the variables which are strongly involved in these relationships are regressed on the remaining explanatory variables to determine the exact nature of these linear relationships.

B. Heteroskedasticity

By the assumption (2.1.3c) of the linear model $Y = Xb + u$ we have

2.5.10 $E(uu') = \sigma^2 I_T$

which means that the variance of the disturbance term is constant, that is the variance is homoskedastic.

But there are occasions, as for example in examining cross section data, that the assumption of constant variance is not realistic. Thus, there are cases where it is plausible to assume that there are unequal variances, which may vary among observations. In this case the variance is said to be heteroskedastic, and (2.5.10) assumption becomes

$$2.5.11 \qquad E(uu') = \sigma^2\Omega$$

where Ω is a positive definite diagonal matrix with not identical elements, and the i-th diagonal element given by σ_i^2.

In the presence of heteroskedasticity the OLS estimates of the parameters are not efficient (minimum variance) although they are still unbiased. In addition the estimated variance of the parameters estimates will be biased.

In the general case, when the structure of the diagonal matrix Ω is unknown, estimation is not possible, as there are more parameters to be estimated than observations. Thus the need arise to parametrize the form of Ω by assuming a particular structure fot it. The objective is to make the variances σ_i^2 a function of a small number of parameters, thus permitting estimation.

The common approach is to postulate that the variances σ_i^2 are functions of one of the explanatory variables X_j, for example

$$2.5.12 \qquad \sigma_i^2 = \sigma^2 X_j^2$$

that is the variance of the disturbance term increases with the square of X_j and where σ^2 is unknown.

For the above example the elements of the Ω matrix are X_j^2. After imposing this particular structure we can estimate the model by applying the GLS estimator (2.3.11).

To test for the null hypothesis of homoskedasticity against the alternative hypothesis of, say, $E(uu') = \sigma^2 X_j^2$ the Goldfield and Quandt test can be employed.

For the application of this test the following steps should be carried out:

(i) The data are ordered according to the magnitude of the variable X_j which is related to the disturbance variance.

(ii) The q central observations are omitted.

(iii) Separate regressions by OLS are fitted to the first and the last $\frac{T-q}{2}$ observations.

(iv) For each regression the sum of the squared residuals is calculated, with SSE_1 denoting the sum associated with the small values of X_j, and SSE_2 the sum related to the large values of X_j.

(v) Assuming that the error terms are normally distributed and not autocorrelated, the ratio $R = \frac{SSE_2}{SSE_1}$, under the homoskedasticity assumption, has an F distribution with $\frac{[T-q-2k]}{2}$ degrees of freedom for both the numerator and the denominator (k is the number of parameters to be estimated). The null hypothesis is then rejected if the calculated value of the R statistic is greater than the critical value of the F distribution.

C. Autocorrelation and Lagged Variables

For the linear model $Y = Xb + u$ the assumption (2.1.3c) implies that the covariance of the disturbance term is zero, that is $E(u_t u_{t+r}) = 0$ for all t and for $r \neq 0$.

This assumption often breaks down especially in time series models, in which case the disturbances for different time periods are correlated. Thus the assumption (2.1.3c) becomes

$$E(uu') = \sigma^2 \Omega \text{ where } \Omega \text{ is not diagonal.}$$

Since the estimation involves $\frac{T(T-1)}{2}$ unknown parameters the assumption of stationarity is imposed on the matrix Ω. This assumption implies that the probability distribution of u_t of the time period in which it was observed and thus the mean and the variance-covariance of u_t is independent of t.

In this case the Ω matrix can be written as

$$2.5.13 \qquad \Omega = \sigma_u^2 \begin{bmatrix} 1 & \rho_1 & \rho_2 & \cdots\cdots & \rho_{T-1} \\ \rho_1 & 1 & \rho_1 & \cdots\cdots & \rho_{T-2} \\ \cdot & \cdot & \cdot & \cdot\ \cdot\ \cdot & \\ \rho_{T-1} & \rho_{T-2} & \rho_{T-3} & \cdot\ \cdot\ \cdot & 1 \end{bmatrix}$$

where $\rho_r = \dfrac{E(u_t - u_{t-r})}{\sigma_u^2}$ $(r = 1,2,\ldots\ldots,T-1)$ is the correlation between the disturbances r periods apart. The number of parameters to be estimated is further reduced if we assume that u_t follows a first order autoregressive process

2.5.14 $u_t = \rho u_{t-1} + v_t$ with $E(v_t) = o$ and

$$E(v_t v_{t+r}) = \begin{cases} \sigma_r^2 & \text{with } r = o \\ = o & \text{with } r \neq o \end{cases}$$

and $|\rho| < 1$ to satisfy the stationarity assumption.

The expression (2.5.14) by continuous substitution of lagged u_t can be written as

$$2.5.15 \qquad u_t = \sum_{r=0}^{\infty} \rho^r v_{t-r} \quad \text{with variance } V(u_t) = \frac{\sigma_v^2}{1-\rho^2} = \sigma_u^2$$

thus in the case the disturbances follow the process of (2.5.14) the variance-covariance matrix of u_t is(12)

$$2.5.17 \qquad E(uu') = \sigma_u^2 \begin{bmatrix} 1 & \rho & \rho^2 & \cdots\cdots & \rho^{T-1} \\ \rho & 1 & \rho & \cdots\cdots & \rho^{T-2} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \rho^{T-1} & \rho^{T-2} & \rho^{T-3} & \cdots & 1 \end{bmatrix} = \sigma_u^2 \Omega$$

If the linear model with autocorrelated disturbances is estimated by OLS the estimates of the parameter vector b will be unbiased but not efficient as they will have large variances. The OLS estimate of the variance $\sigma_u^2(X'X)^{-1}$ will be biased while the generated forecasts will be also inefficient.

Because of these serious consequences it is necessary to test for the presence of autocorrelation in the disturbances. The most commonly used test is the Durbin-Watson test (d) with the null hypothesis of no autocorrelation. The calculation of the Durbin-Watson statistic is based on the OLS residuals and is defined as

2.5.18 $$d = \frac{\sum_{t=2}^{T} (e_t - e_{t-1})^2}{\sum_{t=1}^{T} e_t^2}$$

As the autocorrelation coefficient is (2.5.19)

$$\rho = \frac{\sum_{t=2}^{T} e_t e_{t-1}}{\sum_{t=2}^{T} e_t^2}$$

an approximate relation can be established between ρ and d which has the form

2.5.20 $$d \simeq 2(1-\rho)$$

From the above relation it follows that when:

$\rho = 1$ then $d = 0$

$\rho = 0$ then $d = 2$ and

$\rho = -1$ then $d = 4$

The probability distribution of d cannot be calculated because it depends on the values of the X matrix. Thus only the upper (d_u) and lower (d_L) limits for the level of significance of d were established which are then used to test the hypothesis of no autocorrelation against the alternative $\rho \neq o$ with the following rules;

If $d < d_L$ the hypothesis of positive autocorrelation is accepted

$d_u < d < 4-d_u$ the hypothesis of no autocorrelation is accepted

$d > 4-d_L$ the hypothesis of negative autocorrelation is accepted

if $d_L \leq d \leq d_u$ or $4-d_u \leq d \leq 4-d_L$ the test is inconclusive.

Once the presence of autocorrelation is established the parameter vector should be estimated by GLS which provides best linear unbiased estimates. The GLS estimator defined in (2.3.11) is $\hat{b}_* = (X'\Omega^{-1}X)^{-1} X'\Omega^{-1}Y$.

In applying the GLS procedure we are seeking a transformation matrix P such that the disturbance of the relation PY=PXb+Pu will haveconstant variance, that is E(Puu'P') $= \sigma^2 I_T$ and thus $P'P = \Omega^{-1}$.

In the case of a first order autocorrelation process for u_t the matrix P and consequently Ω^{-1} are

$$2.5.2.1 \qquad P = \begin{bmatrix} \sqrt{1-\rho^2} & 0 & 0 & \cdots\cdots & 0 & 0 \\ -\rho & 1 & 0 & \cdots\cdots & 0 & 0 \\ 0 & -\rho & 1 & \cdots\cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \cdots\cdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots\cdots & 1 & 0 \\ 0 & 0 & 0 & \cdots\cdots & -\rho & 1 \end{bmatrix}$$

$$2.5.2.2 \qquad \Omega^{-1} = \begin{bmatrix} 1 & -\rho & 0 & \cdots\cdots & 0 & 0 \\ -\rho & 1+\rho^2 & -\rho & \cdots\cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \cdots\cdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots\cdots & 1+\rho^2 & -\rho \\ 0 & 0 & 0 & \cdots\cdots & -\rho & 1 \end{bmatrix}$$

As the value of ρ generally is not known the GLS estimator cannot be computed directly. The value of ρ has to be estimated and various methods have been proposed. Two of the most common procedures are those proposed by Cochrane and Orcutt and

Hildreth and Lu. Both are based on the assumption of a first order autocorrelation process and produce estimates with the desirable properties in large samples.

The Cochrane-Orcutt method is an iterative process. The OLS residuals are used to estimate the autocorrelation coëfficient ρ. This estimate is employed in the matrix P to transform the original model, that is to estimate it by GLS. Then the estimates of the parameters b are substituted into the original equation and from the new obtained residuals a new estimate of ρ is produced. This process is continued until successive estimates for b and ρ converge. The problem with this technique is that it may lead to local minimum and thus the final value of ρ may not be optimal. The Hildreth-Lu technique is a search procedure. A set of grid values of ρ is specified in the interval -1 and +1 and is spaced by equal steps. For each of these values of ρ the equation is estimated by GLS and the procedure selects that equation and consequently the value of ρ which has the minimum sum of squared residuals.

The Durbin-Watson statistic is applicable when the matrix X of explanatory variables is not stochastic. But in many cases stochastic variables are contained and the most usual case is the inclusion of lagged values of the dependent variable. The lagged values of the dependent variable are included either directly in the context of dynamic modelling or as a result of transformations (adaptive expectation models etc.). In these cases the disturbance term is correlated with the explanatory variables (Y_{t-1}) and the OLS estimates are biased in small samples[13]. The situation is even worse if the disturbances are autocorrelated and as a result the OLS estimates will be not only biased but inconsistent as well.

An alternative to Durbin-Watson test is provided by the calculation of the following statistic:

$$2.5.23 \qquad h = \rho\sqrt{\frac{T}{1-T\ V(b_1)}}$$

where $V(b_1)$ is the estimate of the variance of the coefficient of the lagged dependent variable. The h statistic under the null hypothesis of no autocorrelation is distributed asymptotically as normal with zero mean and unit variance. Models with lagged dependent variables and autocorrelated disturbances require in general non-linear estimation techniques and GLS estimator will not be often successful(14).

A flexible approach to encounter the problems created by the inclusion of a large number of lagged values of one or more variables of the X matrix (multicollinearity, shortage of degrees of freedom) has been provided by Almon's procedure.

Let the model have the form

$$2.5.24 \qquad Y_t = a + b_o X_t + b_1 X_{t-1} + \ldots\ldots + b_r X_{t-r} + u_t$$

where the lagged effects last up to r period.

The polynomial distributed lag model assumes that the lag weights b's can be specified on an unknown function which then can be approximated by a polynomial function of a suitable degree. Thus if it is assumed that the degree of the polynomial is q the lag weights are:

2.5.25 $$b_i = f(i) = c_o + c_1 i + c_2 i^2 + \ldots\ldots + c_q i^q$$
$$i = 0, 1, \ldots . r$$

or in a matrix from b = Hc

where $c' = (c_o, c_1, \ldots, c_q)$ and

$$H = \begin{bmatrix} 1 & 0 & 0 & \ldots\ldots & 0 \\ 1 & 1 & 1 & \ldots\ldots & 1 \\ 1 & 2 & 2^2 & \ldots\ldots & 2^q \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ 1 & r & r^2 & \ldots\ldots & r^q \end{bmatrix}$$

For example taking r = 5 periods and q = 3 degree (2.5.25) becomes

$$b_o = f(0) = c_o$$
$$b_1 = f(1) = c_o + c_1 + c_2 + c_3$$
$$b_2 = f(2) = c_o + 2c_1 + 4c_2 + 8c_3$$
$$b_4 = f(4) = c_o + 4c_1 + 16c_2 + 64c_3$$

Substituting the above expression for b_i into (2.5.24) and re-arranging terms the equation to be estimated is:

2.5.26 $$Y_t = \alpha + c_o(X_t + X_{t-1} + \ldots\ldots + X_{t-4}) + c_1(X_{t-1} + 2X_{t-2} + \ldots\ldots + 4X_{t-4}) + \ldots + c_3(X_{t-1} + 8X_{t-2} \ldots \ldots 64X_{t-4}) + u_t$$

Equation (2.5.26) under the usual assumptions for the error term u_t can be estimated by OLS which will provide best linear unbiased estimates for the c's.

2.6 Non-Linear Estimation

The general non-linear model has the form[15]

$$Y = f(X_1, X_2, \ldots X_k, b_1, b_2, \ldots b_n) + u_t \quad (2.6.1)$$

where f is a non-linear function of the k explanatory variables $X_1, \ldots X_k$ and the n coefficients $b_1, \ldots b_n$ or in a compact form

$$Y = f(X,b) + u_t \quad (2.6.2)$$

The model (2.6.2) is estimated by the minimization of the sum of squared residuals that is

$$S(b) = \sum_{t=1}^{T} (u_t^2) = \sum_{t=1}^{T} [Y_t - f(X,b)]^2 \quad (2.6.3)$$

where T is the number of observations and assuming that the disturbance term is normally distributed the resulting estimates are approximately maximum likelihood.

To minimize the sum of squared residuals, (2.6.3) is differentiated with respect to parameters vector b and the result is the set of non-linear normal equations:

$$\frac{\partial S}{\partial b_i} = \sum_{t=1}^{T} 2[Y_t - f(X,b)] \frac{\partial f}{\partial b_i} = 0 \quad (2.6.4)$$

The set (2.6.4) of the non-linear equations has to be solved simultaneously to determine the estimates of the parameters vector b. One method of estimating the non-linear model is by an iterative linearization process. Equation (2.6.2) is expanded by

Taylor's series around a set of initial values $b_i,0$ of the parameters vector b and becomes

$$2.6.5 \qquad Y = f(X,b) + \sum_{i=1}^{n} \left(\frac{\partial f}{\partial b_i}\right)_o (b_i - b_i,0)$$

$$+ \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \left(\frac{\partial^2 f}{\partial b_i \partial b_j}\right) (b_i - b_i,0)(b_j - b_j,0)$$

$$+ \ldots\ldots + u_t$$

A linear approximation of (2.6.2) is provided by the first two terms of (2.6.5) which by rearranging the remaining terms, gives

$$2.6.6 \qquad Y_t - f\ (X,b) = \sum_{i=1}^{n} b_i,o \left(\frac{\partial f}{\partial b_i}\right)_o = \sum_{i=1}^{n} b_i \left(\frac{\partial f}{\partial b_i}\right)_o + u_t$$

and then (2.6.6) is estimated by OLS to obtain estimates for the parameters vector b_i. These estimates are used as a new set of initial values and the non-linear equation is again linearised around these new values giving

$$2.6.7 \qquad Y_t - f(X,b) + \sum_{i=1}^{n} b_i,1 \left(\frac{\partial f}{\partial b_i}\right)_1 = \sum_{i=1}^{n} b_i \left(\frac{\partial f}{\partial b_i}\right)_1 + u_t$$

and applying OLS a new set of estimates of b_i is obtained. This iterative process is continued until convergence occurs, that is when the following ratio is satisfied:

$$\left| \frac{b_{i,j+1} - b_{ij}}{b_{ij}} \right| < \delta \qquad i = 1,2,\ldots.n$$

and where δ is a small number.

From the estimates of the last iteration standard statistics (R^2, t-statistics) can be computed to evaluate the fit of the linearized equation.

2.7 Simultaneous Equation Systems

An econometric model may consist of several equations which determine simultaneously the endogenous variables. Because of the interdependence of the various economic relations, the set of explanatory variables in each equation of an econometric system, may include other endogenous (dependent) variables. An interdependent linear econometric model then can be written as

2.7.1 $\Gamma Y = BX + U$

where Y is (G*T) matrix of endogenous variables, X is (K*T) matrix of predetermined variables and U is (G*T) matrix of disturbances Γ is (G*G) matrix of the coefficients of the endogenous variables and B is (G*K) matrix of the coefficients of the predetermined variables.

By setting to unity (normalization) arbitrarily the principal diagonal of matrix Γ one endogenous variable in each equation is regarded as the dependent variable. It is assumed that the disturbance vectors are identically normally distributed with zero mean and covariance matrix Σ and they also are not autocorrelated. In addition the disturbance vectors are uncorrelated with the exogenous variables (and the initial values (Y_t, $t = i$) of the lagged endogenous variables if they are involved in the matrix X, that is the lagged endogenous variables are uncorrelated in the limit with the disturbances).

These assumptions in a compact form are

2.7.2
$$\left[\begin{array}{l} U \sim N(0,\Sigma) \\ \text{with } E(U) = 0 \quad E(U\,U') = \Sigma_{(G*G)} \text{ and } E(U_t U_s) = 0 \\ \text{for } t,s = 1,2,\ldots.T \text{ and } t \neq s \\ COV(XU) = 0 \\ \text{However it is allowed that the disturbances can be} \\ \text{correlated across equations and thus} \\ \qquad E(U_g U_h) \neq 0 \ (g,h = 1,2\ldots.G) \end{array}\right.$$

If the matrix Γ is non-singular the reduced form is obtained as

2.7.3
$$Y = \Gamma^{-1}BX + \Gamma^{-1}U \text{ or}$$
$$Y = \Pi X + V$$

where $\Pi = \Gamma^{-1}B$ and $V = \Gamma^{-1}U$

Thus the reduced form gives each endogenous variable as a function of the predetermined variables and all the disturbance vectors (V is a function of $u_1, u_2 \ldots . u_G$). As a consequence the endogenous variables appearing in the set of explanatory variables in each equation will be generally correlated with the error term u_{it} in that equation. The result of the correlation between the explanatory variables and the disturbances, is that the OLS estimates are inconsistent(16). On the other hand as only predetermined variables are included in the set of the explanatory variables of (2.7.3) the reduced form estimates are consistent and thus OLS can be applied.

Although the parameters of the reduced form can be consistently estimated the question arises of whether there exist one or more set of structural coefficients (of the system 2.7.1) corresponding to the estimated reduced form parameters. This problem of identification consists of whether we can solve for the structural parameters from those of the reduced form.

When multiplying (2.7.1) by a non-singular matrix F (G*G) each equation in (2.7.1) will be replaced by a linear combination of the equations in the system:

2.7.4 $\quad F\Gamma Y = FBX + FU$

solving (2.7.4) for its reduced form we obtain

$$(F\Gamma)^{-1}\ (F\Gamma)Y = (F\Gamma)^{-1}(FB)X + (F\Gamma)^{-1}\ FU \text{ or}$$

2.7.5 $\quad Y = \Gamma^{-1}BX + \Gamma^{-1}U$

which is the same as (2.7.3) the reduced form of the system (2.7.1). Thus the original (2.7.1) and the new structural systems (2.7.4) and their reduced forms will be observationally equivalent[(17)]. Consequently the structural parameters are identifiable if they can be uniquely determined from the reduced form parameters.

Identifiability of a structural form can be ensured if restrictions (in the form of exclusion restrictions or linear combinations of the parameters) are placed on the parameters of the structural equations or on the elements of the variance-covariance matrix Σ. Thus the following two conditions should be satisfied so that an equation, say the i-th can be identified:

a) the order condition which states that the number of predetermined variables excluded from i-th equation should be at least equal to the number of endogenous variables included in the i-th equation minus one, that is

2.7.6 $(X - X_{inc}) \geq G_{inc} - 1$

where X is the number of predetermined variables in the model,

X_{inc} = the number of predetermined variables included in the i-th equation and

G_{inc} = the number of endogenous variables included in the i-th equation.

This necessary condition cannot ensure identifiability unless the following sufficient condition, the rank condition is also satisfied.

b) The rank condition states that the rank of at least one of the submatrices formed from the reduced form parameters of the predetermined variables excluded from the i-th equation should be equal to $G_{inc}-1$. That is the order of the largest non-zero determinant which can be formed from the $(X-X_{inc})$ reduced from parameters is $G_{inc}-1$, or

2.7.7 $R(\Pi e) = G_{inc}-1$

where R is the rank of the matrix and Πe is the submatrix of the reduced form parameters of the predetermined variables excluded from the i-th equation. Using the two conditions (2.7.6) and (2.7.7) we can distinguish three cases:

1) If $(X-X_{inc}) > G_{inc} - 1$ and $R(\Pi e) = G_{inc}-1$ the equation is over identified.

2) If $(X-X_{inc}) = G_{inc}-1$ and $R(\Pi e) = G_{inc}-1$ the equation is exactly identified, and

3) If $(X-X_{inc}) \geq G_{inc}-1$ and $R(\Pi e) < G_{inc}-1$ or $(X-X_{inc}) < G_{inc}-1$ the equation is under identified.

The most common method of estimating an over identified structural equation is that of two stage least squares (2SLS). As it is mentioned above the OLS should not be applied on interdependent systems because the endogenous variables, used as explanatory, are correlated with the disturbances. The idea of 2SLS is first to purge these endogenous variables from their stochastic part by applying OLS on the reduced form equations. In the second stage the equation is estimated by regressing the dependent variable on the predetermined variables and the reduced form estimates of the endogenous variables obtained in the first stage.

Let the i-th over identified equation have the form

2.7.8 $$y_i = Y_i \gamma + X_i b + u_i$$

where y_i = (T*1) vector of observations on the i-th dependent variable

Y_i = $(T*G_i)$ matrix of the G_i endogenous explanatory variables included in the i-th equation

γ = (G_i*1) vector of structural parameters of the variables Y_i

X_i = $(T*K_i)$ matrix of the K_i predetermined variables included in the i-th equation

b = (K_i*1) vector of structural parameters of the variables X_i, and

u_i = (T*1) vector of the disturbances of the i-th equation.

The first stage of 2SLS is to estimate Y_i by regressing each variable in Y_i on all the predetermined variables in the model.

Thus the reduced form estimates of Y_i are

$$2.7.9 \qquad \hat{Y}_i = X\hat{\Pi}_i$$

where X is the (T*K) matrix of the predetermined variables in the whole model and $\hat{\Pi}_i$ is the $(K{*}G_i)$ matrix of estimated reduced form parameters for the variables in Y_i.

From (2.1.8) the OLS estimate of $\hat{\Pi}_i$ is

$$2.7.10 \qquad \hat{\Pi}_i = (X'X)^{-1}X'Y_i$$

so that (2.7.9) becomes

$$2.7.11 \qquad \hat{Y}_i = X(X'X)^{-1}X'Y_i$$

The matrix Y_i can be expressed using (2.7.3) as

$$2.7.12 \qquad Y_i = \hat{Y}_i + \hat{V}_i$$

where $\hat{V}_i$ is the matrix of the reduced form residuals.

Substituting (2.7.12) in (2.7.8) gives

$$y_i = Y_i\gamma + X_ib + u_i = (\hat{Y}_i + \hat{V}_i)\gamma + X_ib + u_i \text{ or}$$

$$2.7.13 \qquad y_i = \hat{Y}_i\gamma + X_ib + (u_i + \hat{V}_i\gamma)$$

Finally by writing from (2.7.12) $\hat{Y}_i = Y_i - \hat{V}_i$ and substituting in (2.7.13) we obtain

$$2.7.14 \qquad y_i = (Y_i - \hat{V}_i)\gamma + X_i b + u_i^* \quad \text{where } u_i^* = u_i + \hat{V}_i\gamma$$

In the second stage OLS is applied on (2.7.14) and the 2SLS estimates of the parameters γ and b are:

$$2.7.15 \qquad \hat{\delta} = \begin{bmatrix} \hat{\gamma} \\ \hat{b} \end{bmatrix} = \{[(Y_i - \hat{V}_i)\ X_i]'[(Y_i - \hat{V}_i)\ X_i]\}^{-1}$$

$$[(Y_i - \hat{V}_i)\ X_i]'y_i = \{\begin{bmatrix} (Y_i - \hat{V}_i)' \\ X_i' \end{bmatrix} [(Y_i - \hat{V}_i)\ X_i]\}^{-1}$$

$$\begin{bmatrix} (Y_i - \hat{V}_i)' \\ X_i' \end{bmatrix} y_i = \begin{bmatrix} (Y_i' - \hat{V}_i')(Y_i - \hat{V}_i) & (Y_i' - \hat{V}_i')X_i \\ X_i'(Y_i - \hat{V}_i) & X_i'X_i \end{bmatrix}^{-1}$$

$$\begin{bmatrix} (Y_i' - \hat{V}_i')y_i \\ X_i'y_i \end{bmatrix} = \begin{bmatrix} (Y_i'Y_i - \hat{V}'\hat{Y}_i - \hat{V}_i'\hat{V}_i - \hat{Y}_i'\hat{V}_i) & (Y_i'X_i - \hat{V}_i X_i) \\ X_i'Y_i - X_i'\hat{V}_i & X_i'X_i \end{bmatrix}^{-1}$$

$$\begin{bmatrix} (Y_i' - \hat{V}_i')y_i \\ X_i'y_i \end{bmatrix}$$

after some algebraic manipulations using the equation (2.7.12) $Y_i = \hat{Y}_i + \hat{V}_i$. Because the first stage residuals are uncorrelated with all the predetermined variables $\hat{V}_i'X = X'\hat{V}_i = 0$.

As $\hat{Y}_i$ is a linear combination of predetermined variables $\hat{Y}_i'\hat{V}_i = \hat{V}_i'\hat{Y}_i = 0$ thus

$$2.7.16 \qquad \hat{\delta} = \begin{bmatrix} \hat{\gamma} \\ \hat{b} \end{bmatrix} = \begin{bmatrix} (Y_i'Y_i - \hat{V}_i\hat{V}_i) & Y_i'X_i \\ X_i'Y_i & X_i'X_i \end{bmatrix}^{-1} \begin{bmatrix} (Y_i' - \hat{V}_i')y_i \\ X_i'y_i \end{bmatrix}$$

$Y_i'Y_i = (\hat{Y}_i + \hat{V}_i)'(\hat{Y}_i + \hat{V}_i) = \hat{Y}_i'\hat{Y}_i + \hat{V}_i'\hat{V}_i$ because of the above conditions, thus

2.7.17 $$\hat{Y}_i'\hat{Y}_i = (Y_i'Y_i - \hat{V}_i'\hat{V}_i)$$

substituting for $\hat{Y}_i$ from (2.7.11) we obtain

2.7.18 $$\hat{Y}_i'\hat{Y}_i = (Y_i'Y_i - \hat{V}_i'\hat{V}_i) = [X(X'X)^{-1}X'Y_i]'[X(X'X)^{-1}X'Y_i]$$

$$= Y_i'X(X'X)^{-1}X'Y_i$$

and also that $(Y_i' - \hat{V}_i')y_i$ is

2.7.19 $$(Y_i' - \hat{V}_i')y_i = \hat{Y}_i'y_i = Y_i'X(X'X)^{-1}X'y_i$$

Substituting (2.7.18) and (2.7.19) into (2.7.16) the 2SLS estimates in terms of the original variables are:

2.7.20 $$\hat{\delta} = \begin{bmatrix} \hat{\gamma} \\ \hat{b} \end{bmatrix} = \begin{bmatrix} Y_i'X(X'X)^{-1}X'Y_i & Y_i'X_i \\ X_i'Y_i & X_i'X_i \end{bmatrix}^{-1} \begin{bmatrix} Y_i'X(X'X)^{-1}X'y_i \\ X_i'y_i \end{bmatrix}$$

or in a compact form

2.7.21 $$\hat{\delta} = (Z'Z)^{-1} Z'y_i \text{ where } Z = [Y_i \; X_i]$$

The 2SLS estimator $\hat{\delta}$ is consistent and its variance covariance matrix is asymptotically normally distributed and is estimated from

$$2.7.22 \qquad S^2(Z'Z)^{-1} = S^2 \begin{bmatrix} Y_i'X(X'X)^{-1}X'Y_i & Y_i'X_i \\ X_i'Y_i & X_i'X_i \end{bmatrix}^{-1}$$

where (2.7.23) $S^2 = \dfrac{(y_i - Y_i\hat{\gamma} - X_i\hat{b})'(y_i - Y_i\hat{\gamma} - X_i\hat{b})}{T - G_i - K_i}$

2.8 Factor Analysis and Principal Components

Factor analysis specifies that the relations in a set of variables Z_i can be explained by a number of general factors. The number of these underlying factors which influence the variables under examination is usually smaller than the number of Z_i variables and thus a considerable simplification of the interrelations between them can be achieved.

The problem of determining these factors can be approached in several ways, but two main aims can be distinguished a) to extract the maximum possible variance and b) to reproduce as closely as possible the observed correlations between the Z_i variables. Of these two objectives the first leads to the principal components analysis and the second to the classical factor analysis[18].

The model for the principal components is written as

$$(2.8.1) \qquad Z_i = a_{i1}F_1 + a_{i2}F_2 + \ldots\ldots + a_{in}F_n \qquad (i = 1,2,\ldots.n)$$

where the right hand side variables are linear combinations of the new variables F_1, F_2,....F_n (components) which are uncorrelated and each of these components makes a maximum contribution to the total variance in the n variables Z_i. In empirical applications only few components, which account for a large part of the total variance, are retained, but all of them are required to reproduce the correlation between the variables.

In classical factor analysis, which aims at reproducing the correlations, it is postulated that the variables Z_i can be explained by m common factors and a unique factor. The factor model can be formulated as

$$2.8.2 \qquad Z_i = a_{i1}F_1 + a_{i2}F_2 + \ldots\ldots + a_{im}F_m + b_iU_i \quad (i = 1,2,\ldots\ldots n)$$

The common factors account for the correlations among the variables while the unique factor accounts for the remaining variance. The coefficients a_{ij} are usually called factor loadings. Applied factor analysis is usually concerned with the common factors and the determination of their coefficients, so that the unique factor coefficient is assumed zero. Thus in applications the factor model is

$$2.8.3 \qquad Z_i = a_{i1}F_1 + a_{i2}F_2 + \ldots\ldots + a_{im}F_m \qquad (i = 1,2,\ldots\ldots n)$$

The number of factors m is usually much smaller than the number n of the variables. In factor analysis (and principal components) the original variables are first standardised. The reason is that the original variables are measured in different units and thus it is very difficult to attach a meaning to concepts as total variation in the variables involved in the analysis and to comtributions of each factor to total variance.

To facilitate hence comparisons the original variables are standardised, that is Z_i in (2.8.2) are assumed to be standardised.

The common factors F_j $(j = 1,2,\ldots,m)$ and the unique factor U_i in (2.8.2) are assumed to be also standardised and independent of each other. Thus the following conditions should be satisfied (where T is the number of observations).

$$\overline{Z_i} = \frac{\sum_{t=1}^{T} Z_{it}}{T} = 0 \qquad S^2_{Z_i} = \frac{\sum_{t=1}^{T} Z^2_{it}}{T} = 1$$

$$\overline{F_j} = \frac{\sum_{t=1}^{T} F_{jt}}{T} = 1 \qquad S^2_{F_j} = \frac{\sum_{t=1}^{T} F^2_{jt}}{T} = 1$$

2.8.4
$$S_{F_jF_s} = \frac{\sum_{t=1}^{T} F_{jt}F_{st}}{T} = 0 \quad (j \neq s)$$

$$\overline{U_i} = \frac{\sum_{t=1}^{T} U_{it}}{T} = 0 \qquad S^2_{U_i} = \frac{\sum_{t=1}^{T} U^2_{it}}{T} = 1$$

$$S_{U_iU_q} = \frac{\sum_{t=1}^{T} U_{it}U_{qt}}{T} = 0 \quad (i \neq q)$$

and
$$S_{f_jU_i} = \frac{\sum_{t=1}^{T} F_{jt}U_{it}}{T} = 0$$

As the variables Z_i are standardised their variance-covariance matrix is a correlation matrix. That is

2.8.5 $$S_{Z_iZ_k} = \frac{\sum_{t=1}^{T} Z_{it}Z_{kt}}{T} = r_{ik} \quad (i \neq k)$$

$$S^2_{Z_i} = \frac{\sum_{t=1}^{T} Z_{it}Z_{it}}{T} = 1 = r_{ii}$$

The factor model can be written in a matrix form as

2.8.6 $$Z = AF$$

The product of the matrix Z multiplied by its transpose and using the relations 2.8.6 is

2.8.7 $$ZZ' = \begin{bmatrix} \sum_{t=1}^{T} Z_{1t}Z_{1t} & \cdots\cdots & \sum_{t=1}^{T} Z_{1t}\,Z_{nt} \\ \vdots & & \vdots \\ \sum_{t=1}^{T} Z_{nt}Z_{1t} & \cdots\cdots & \sum_{t=1}^{T} Z_{nt}Z_{nt} \end{bmatrix} = \begin{bmatrix} Tr_{11} & \cdots\cdots & Tr_{1n} \\ \vdots & & \vdots \\ Tr_{n1} & \cdots\cdots & Tr_{nn} \end{bmatrix} = TR$$

where R is the (n*n) correlation matrix of the standardised variables Z_i, with elements on the main diagonal equal one, thus

2.8.8 $$R = \frac{1}{T} ZZ'$$

Considering (2.8.2) and taking into consideration the conditions (2.8.4) and (2.8.5) the variance of each variable Z_i is

2.8.9 $$S^2_{Z_i} = \frac{\sum_{t=1}^{T} Z_{it} Z_{it}}{T} = \frac{1}{T} \left[\sum_{t=1}^{T} (a_{i1}F_{1t} + a_{i2}F_{2t} + \ldots\ldots + a_{im}F_m + b_i U_{it})^2 \right] = \sum_{j=1}^{m} a^2_{ij} \left(\frac{\sum_{t=1}^{T} F^2_{jt}}{T} \right)$$

$$+ b^2_i \left(\frac{\sum_{t=1}^{T} U^2_{it}}{T} \right) + 2 \sum_{j=1}^{m} \sum_{s=1}^{m} a_{ij} a_{is} \left(\frac{\sum_{t=1}^{T} F_{jt} F_{ht}}{T} \right) +$$

$$2b_i \sum_{j=1}^{m} a_{ij} \left(\frac{\sum_{t=1}^{T} F_{jt} U_{it}}{T} \right) = \sum_{j=1}^{m} a^2_{ij} + b^2_i \quad (1 = 1,2,\ldots.n)$$

In factor analysis $\Sigma a^2_{ij} = h^2_i$ is called communality and accounts for that part of the total variance which relates to the variance of other variables, that is this part of the variance associated with the common factors.

2.8.10 $$h^2_i = a^2_{i1} + a^2_{i2} + \ldots. + a^2_{im} = \sum_{j=1}^{m} a^2_{ij} \quad \text{thus}$$

2.8.11 $S^2_{Z_i} = h^2_i + b^2_i$ and from the conditions (2.8.4) and (2.8.5)

2.8.12 $$S^2_{Z_i} = 1 = r_{ii} = h^2_i + b^2_i$$

Substituting for Z from (2.8.6) into (2.8.8) we obtain

2.8.13 $$R = \frac{1}{T} ZZ' = \frac{1}{T} (AF)(AF)' = \frac{1}{T} AFF'A'$$

By assumption the factors F_j have zero mean and unit variance and consequently the product matrix $\frac{1}{T}(FF')$ is the correlation matrix between the factors. As the factors have unit variance and zero covariances their correlation matrix is an identity matrix, that is

$$\frac{1}{T}(FF') = I_m \quad \text{or } FF' = TI_m$$

and substituting into (2.8.13) for FF' we derive

2.8.14 $\quad R = AA'$

Thus as (2.8.14) shows the product AA' reproduces a correlation matrix. But the product AA' does not exactly equal the original correlation matrix R, because A is a$(n*m)$ matrix which contains only the common component (h_i^2) and not the unique component (b_i^2) of the total variance as well. The principal diagonal of the reproduced correlation matrix in (2.8.14) does not contain unities which is necessary as (2.8.12) shows, in order to reproduce exactly the original correlation matrix R and consequently the reproduced matrix is

2.8.15 $\quad R* = AA'$

The main task of factor analysis is the determination of the matrix A of factor loadings. The analysis requires the calculation of the correlation matrix R of the variables Z_i. This matrix is of order n and has unities in the principal diagonal as the conditions (2.8.5) and (2.8.12) show.
On the other hand the factor model contains m factor thus the determination of factor loadings, which depends on matrix R, can

be carried out either with unities in the main diagonal of R or with communalities (h_i^2 $i = 1,2,\ldots,n$), the latter being less than one (2.8.12). To use communalities in the main diagonal depends on the number of factors to be used. Thus an arbitrary choice has to be made beforehand on the number of factors employed. One way to avoid this arbitrariness is to use in the analysis the correlation matrix R with unities on the main diagonal. This approach is used by the principal components analysis. The determination of the factor loading matrix A for principal components and factor analysis is not significantly different. In both cases the starting point is the calculation of the first column of matrix A. The difference is the number of side conditions involved in the determination of the first column of A. In principal components model the number of components (F_j) involved is n and there are n side conditions while in the factor model the number of side conditions is m as the number of factors involved is limited to m.

Applying the principal component model[19] the aim is to maximize the contribution of the first factor F_1 to the total variance of the variables Z_i ($i = 1,2,\ldots,n$). This contribution from (2.8.10) is $\sum_{i=1}^{n} a_{i1}^2$

Thus for the first factor we have to maximize

$$2.8.16 \qquad V_1 = \sum_{i=1}^{n} a_{i1}^2$$

subject to $\frac{1}{2}\, n(n+1)$ independent side conditions[20] among the coefficients a_{ij} in order to reproduce the correlation matrix R* from matrix A (2.8.15), that is

$$2.8.17 \qquad r_{ip} = \sum_{j=1}^{n} a_{ij}a_{pj} = a_{i1}a_{p1} + a_{i2}a_{p2} +$$

$$\ldots\ldots\ldots + a_{in}a_{pn} \qquad (i,p = 1,2,\ldots.n)$$

Using the Lagrange multiplier method we form the function

$$2.8.18 \qquad 2T_1 = V_1 - \sum_{i,p=1}^{n} h_{ip}r_{ip} = \sum_{i=1}^{n} a_{i1}^2 - \sum_{i,p=1}^{n} \sum_{j=1}^{n} \mu_{ip}a_{ij}a_{pj}$$

where μ_{ip} are the Lagrange multipliers. Because of the symmetry of the correlation matrix we have $\mu_{ip} = \mu_{pi}$.
To determine the maximum of (2.8.18) we have to evaluate its partial derivatives with respect to a_{ij} and equate them to zero. Writing (2.8.18) in the form

$$T_1 = \frac{1}{2} \sum_{i=1}^{n} a_{i1}^2 - \frac{1}{2} \sum_{i,p=1}^{n} \sum_{j=1}^{n} \mu_{ip}a_{ij}a_{pj}$$

the partial derivatives are

$$2.8.19 \qquad \frac{\partial T_1}{\partial a_{ij}} = 0$$

This derivation can be performed in two steps. First the derivatives of T_1 are evaluated with respect to a_{i1} and set equal to zero, and then the rest of the derivatives with respect to a_{ij} $(j \neq 1)$ are derived. Thus, using the Kronecker $\delta_{1j} = 1$ for $j = 1$ and $\delta_{1j} = 0$ for $j \neq 1$ we get

2.8.20 $$\frac{\partial T_1}{\partial a_{ij}} = \delta_{1j} a_{i1} - \sum_{p=1}^{n} \mu_{ip} a_{pj} = 0 \quad (i,j = 1,2,\ldots..n)$$

Multiplying (2.8.20) by a_{i1} and summing up with respect to i gives

2.8.21 $$\delta_{1j} \sum_{i=1}^{n} a_{i1}^2 - \sum_{i=1}^{n} \sum_{p=1}^{n} \mu_{ip} a_{i1} a_{pj} = 0$$ and from (2.8.20) for j = 1 it follows (2.8.22) $\sum_{p=1}^{n} \mu_{ip} a_{p1} = a_{i1}$ as the i and p may be interchanged and because of the symmetry of $\mu_{pi} = \mu_{ip}$ we have

2.8.22 $$\sum_{i=1}^{n} \mu_{pi} a_{i1} = a_{p1} \quad (p = 1,2,\ldots..n)$$ and

2.8.23 $$\sum_{i=1}^{n} \mu_{ip} a_{i1} = a_{p1}$$

Setting $\sum_{i=1}^{n} a_{i1}^2 = \lambda 1$ (2.8.24) and substituting the last relation and (2.8.23) into (2.8.21) we get

2.8.24 $$\delta_{1j} \lambda_1 - \sum_{p=1}^{n} a_{p1} a_{pj} = 0$$

Multiplying (2.8.24) by a_{ij} and summing with respect to j

2.8.25 $$\sum_{i=1}^{n} \delta_{1j} a_{ij} \lambda_1 - \sum_{p=1}^{n} \sum_{j=1}^{n} a_{p1} a_{pj} a_{ij} = 0$$

As $\delta_{1j} = 0$ for $j \neq 1$ and $\delta_{1j} = 1$ for $j = 1$ and taking into consideration the reversibility of the double sum (2.8.25) can be written

2.8.26 $$a_{i1} \lambda_1 - \sum_{p=1}^{n} a_{p1} \left(\sum_{j=1}^{n} a_{ij} a_{pj} \right) = 0$$

From (2.8.17) $\sum_{j=1}^{n} a_{ij}a_{pj} = r_{ip}$ thus (2.8.26) after substitution becomes (2.8.18) $\sum_{p=1}^{n} r_{ip}a_{p1} - \lambda_1 a_{i1} = 0$ (i=1,2,....,n)

Taking into consideration that $r_{ii} = 1$ and expanding (2.8.18) in matrix form we have

$$2.8.19 \quad \begin{bmatrix} 1 & r_{12} & \cdots\cdots & r_{1n} \\ r_{21} & 1 & \cdots\cdots & r_{2n} \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ r_{n1} & r_{n2} & \cdots\cdots & r_{nn} \end{bmatrix} \begin{bmatrix} a_{11} \\ a_{21} \\ \cdot \\ \cdot \\ \cdot \\ a_{n1} \end{bmatrix} - \lambda_1 \begin{bmatrix} a_{11} \\ a_{21} \\ \cdot \\ \cdot \\ \cdot \\ a_{n1} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \cdot \\ \cdot \\ \cdot \\ 0 \end{bmatrix}$$

Or generalising in a compact form we get

$$2.8.20 \quad (R-\lambda I)a_1 = 0$$

This system of linear homogeneous equations (2.8.20) has a non-trivial solution if its determinant is equal to zero. As a correlation matrix, R is symmetric, real and positive semi-definite. The solution of its characteristic equation, which is

$$2.8.21 \quad |R-\lambda I| = 0$$

gives n real and positive roots, which arranged in a descending order is

$$2.8.22 \quad \lambda_1 \geq \lambda_2 \geq \cdots\cdots\cdots \geq \lambda_n \geq 0$$

to which the V_1, $V_2 \ldots\ldots V_n$ characteristic vectors correspond. These characteristic vectors are orthogonal. As V_1 should be maximised, the largest characteristic root λ_1 is substituted in (2.8.19) and the corresponding characteristic vector is derived, that is $V_1' = (v_{11}, v_{21} \ldots\ldots v_{n1})$. As the variables Z_i are normalised we have to normalise the characteristic vectors in order to calculate the factor loadings a_{ij} so that (2.8.16) is satisfied. To normalise the characteristic vectors, each of the elements of V_1' is divided by the square root of the sum of their squares thus

$$V_{i1}^{*} = \frac{V_{i1}}{\sqrt{v_{11}^{2} + v_{21}^{2} + \ldots\ldots v_{n1}^{2}}}$$

and the normalised eigenvectors is then (2.8.23) $V_1^{*} = \dfrac{V_1}{\sqrt{V_1' V_1}}$

where V_1^{*} stands for the normalised eigenvectors and which satisfies the conditions (2.8.16) and (2.8.17). Between the factor loadings and the normalised characteristic vectors exists the followinr elation

2.8.24 $\quad a_1 = V_1^{*} \sqrt{\lambda 1}$

The next step is to calculate the second column of A which account for the maximum of the residual variance, and thus the residual correlation matrix is required denoted by R_1.

$$\text{Thus } R_1 = R - \hat{R}_1 \text{ where } \hat{R}_1 = a_1 a_1'$$

and the same maximization procedure should be followed, in order to determine the largest characteristic root of the characteristic equation which corresponds to the residual correlation matrix R_1 and which maximize the contribution of the second factor F_2 in the residual variance of the variables Z_i. It can be shown(21) that this characteristic root is equal to the second largest root λ_2 of the correlation matrix R.

By determining all other characteristic vectors (normalised) by the same method, the equation to be solved is

2.8.25 $\quad RV^* = V^*\Lambda$ where Λ is a diagonal matrix

premultiplying (2.8.25) by V_*^{-1} gives

2.8.26 $\quad V_*^{-1}RV_* = \Lambda$

So this transformation diagonalises R. Λ is the matrix of the characteristic roots and V_* the matrix of characteristic vectors. Since R is symmetric $R = R'$ and by transposing (2.8.26) we get $V_*'R(V_*^{-1})' = \Lambda$ which shows that V_* is orthogonal and thus $V_*'V_*' = I$, $V_*^{-1} = V_*'$ (2.8.27)

These properties finally give $V_*'RV_* = \Lambda$

Premultiplying the above relation by V_* and postmultiplying by V_*' we obtain

2.8.28 $\quad R = V_*\Lambda^{\frac{1}{2}}\Lambda^{\frac{1}{2}}V_*'$

which is the determination of the principal components model. Apart from conceptual ones the basic difference between factor analysis and the principal component model is that the latter involves the determination of all the n characteristic roots and the associated characteristic vectors (although in applications a small number is retained). On the other hand factor analysis (which distinguishes between common and unique factors) involves a smaller number of characteristic roots and vectors, as the number of factors is m which is smaller than the number n of variables Z_i. In this case the matrix of scaled normalised vectors cannot satisfy the orthogonality properties (2.8.27). The reason is, that A is of order (n*m) and its inverse does not exist. The corresponding orthogonality property for A is

2.8.29 $A'A = \Lambda_m$ where Λ_m is a diagonal matrix of order m with elements λ_j (j = 1,2,....m). The utilization of m characteristic roots restricts (2.8.28) to the first m λ_j,s and becomes equal to (2.8.15). Thus

2.8.30 $R^* = V_{*j} \Lambda_j^{\frac{1}{2}} \Lambda_j^{\frac{1}{2}} V'_{*j} = AA'$ from which it follows that

2.8.31 $A = V_{*j}\Lambda_j^{\frac{1}{2}}$ (j = 1,2,....m)

Thus the vectors of matrix A are proportional to the characteristic vectors V_{*j}.

In applications a small number of factors or components is retained. Usually the number of factors depends on the amount of variance they account for, say over 90 percent, or if their corresponding characteristic roots exceed unity, but formal statistical tests have been also developed.

The aim of factor analysis is not only to determine the factor loadings matrix A but that the factors have a meaningful interpreation. Usually the matrix A produced by this procedure is not suitable for interpretation of the relations under investigation. Hence the determination of a final matrix A is sought, which is accomplished by the rotation of the factors of the initial matrix A. This is achieved by replacing a pair of old by a pair of new column vectors in the initial matrix A. The two factors are transformed by rotating their system of axes to two new factors. The rotation could be orthogonal or oblique, the latter allowing the factors to be correlated.

The rotation is realised by the transformation matrix

$$2.8.32 \qquad T = \begin{bmatrix} \cos\phi & -\sin\phi \\ \sin\phi & \cos\phi \end{bmatrix}$$

where ϕ is the rotation angle between the new and the old axes system, that is T is the matrix of direction cosines. The resulting matrix of the final factor loadings (B), after an orthogonal rotation, is also orthogonal and it is given by

$$2.8.33 \qquad B = AT$$

In the case of oblique rotation not only the factor pattern ($Z = AF$ where a_{ij} are the pattern coefficients) is required but also the factor structure[22], that is the correlations between the variables and the factors, which can be represented as:

$$
2.8.34 \quad \left[\begin{array}{l}
r_{z_i f_1} = a_{i1} + a_{12}\, r_{f_1 f_2} + \cdots\cdots + a_{im} r_{f_1 f_m} \\
\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
r_{Z_i f_m} = a_{i1} r_{f_m f_1} + a_{12} r_{f_m f_2} + \cdots\cdots + a_{im}
\end{array}\right]
$$

or in matrix notation the structure matrix is

$$
2.8.35 \qquad S = \begin{bmatrix} \sigma_{11} & \cdots\cdots & \sigma_{1n} \\ \vdots & & \vdots \\ \sigma_{n1} & \cdots\cdots & \sigma_{nn} \end{bmatrix} \quad \text{where } S_{ij} = r_{Z_i f_j} \quad (i,j = 1,2,\ldots.n)
$$

The structure matrix (S) is related to pattern matrix P by the relation

$$2.8.36 \qquad S = P\Theta$$

where Θ is the matrix of the correlations between the factors and is given by

$$2.8.37 \qquad \Theta = T'T$$

where T is the transformation matrix which contains in its columns the direction cosines of the oblique axes with respect to the orthogonal frame of reference[23].

If the initial factor pattern A is used the oblique pattern matrix (P) is

$$2.8.38 \qquad P = A(T')^{-1}$$

In the case of orthogonal factors the total contribution of a factor to the variance of all variables is $V_j = \sum_i^n a_{ip}^2$ $(p = 1,2,\ldots,n)$. But when the factors are correlated (oblique factors) the total contribution of a factor to the variance of all variables comes not only from its own impact but also through its interaction with other factors, thus

2.8.39 $$V_j = \sum_{i=1}^{n} b_{ij}^2 + 2r_{T_pT_q} \sum_{i=1}^{n} b_{ip}b_{iq} \quad (p,q = 1,2,\ldots,m;\ p < q)$$

As these transformations are based on subjective criteria, methods have been devised to establish the conditions of a simple, and thus meaningful, structure of an objective framework. One of the most commonly used methods in the case of orthogonal rotation, is the Varimax criterion proposed by Kaiser[24]. The simplicity of the factor is defined as the variance of its square loadings and when variance is maximum, simplicity is attained as the final factor loadings (b_{ij}'s) approach unity or zero. Thus the final factor loadings should maximise the function

2.8.40 $$V = n \sum_{j=1}^{n} \sum_{i=1}^{n} \left(\frac{b_{ij}}{h_i} \right)^4 - \sum_{j=1}^{n} \left(\sum_{j=1}^{n} \frac{b_{ip}^2}{h_i^2} \right)^2$$

where $h_i = \sqrt{a_i1^2 + a_{i2}^2 + \ldots\ldots + a_i^2 n}$

For the case of oblique factors the Oblimin criterion requires the minimization of the function

2.8.41 $$F(P) \sum_{j<p=1}^{m} \left(\sum_{i=1}^{n} b_{ij}^2 b_{ip}^2 - \frac{\delta}{n} \sum_{i=1}^{n} b_{ij}^2 \sum_{j=1}^{n} b_{ip}^2 \right)$$

where P is the final pattern matrix and the parameter δ controls the correlation between the factors.

In applications of the factor analysis technique measurements of factors are required in many cases.

In the case of principal components (with unities in the main diagonal of R) factor measurements in terms of the observed variables Z_i are derived by using the relation $Z = AF$ by inverting matrix A which in this case is non-singular, thus

2.8.42 $\quad F = A^{-1}Z$

When the matrix A is of order ($n*m$) that is when m factors or principal components are used, to get factor measurements the above relation $Z = AF$ is premultiplied by A' giving $\quad A'Z = A'AF$

This function is premultiplied by $(A'A)^{-1}$ and results in

2.8.43 $\quad F = (A'A)^{-1}A'Z = \Lambda_m^{-1} A'Z$

from which factor measurements are calculated.

Many times in econometrics studies the number of explanatory variables X is large leaving few degrees of freedom and thus meaningful estimation is precluded.

In some cases, in systems of equations, the number of predetermined variables in the matrix X is very large so that it exceeds the number of observations and 2SLS procedure cannot be applied. A method of solving this problem is to reduce the number of predetermined variables by using the principal components analysis. The retained principal components are then employed in the first stage to estimate the reduced form.

From (2.7.20) the 2SLS estimator is:

$$2.8.44 \quad \hat{\delta} = \begin{bmatrix} \hat{\gamma} \\ \hat{b} \end{bmatrix} = \begin{bmatrix} Y_i'X(X'X)^{-1}X'Y_i & Y_i'X_i \\ X_i'Y_i & X_i'X_i \end{bmatrix}^{-1} \begin{bmatrix} Y_i'X(X'X)^{-1}X'y_i \\ X_i'y_i \end{bmatrix}$$

where X is the matrix of the predetermined variables in the whole system and can be partitioned as

$$2.8.45 \qquad X = [X_i \; X_j]$$

where X_i is the matrix of the predetermined variables included in the equation which determines y_i and X_j the matrix of the predetermined variables which are in the system but are excluded from the equation to be estimated (y_i).

The method of 2SLS with principal components[25] consists basically in replacing the matrix X by the matrix Z which is

$$2.8.46 \qquad Z = [X_i \; F_j]$$

where X_j has been replaced by the (T*K) matrix F_j of K principal components. Thus the 2SLS estimator becomes

$$2.8.47 \quad \hat{\delta} = \begin{bmatrix} \hat{\gamma} \\ \hat{b} \end{bmatrix} = \begin{bmatrix} Y_i'Z(Z'Z)^{-1}Z'Y_i & Y_i'X_i \\ X_i'Y_i & X_i'X_i \end{bmatrix}^{-1} \begin{bmatrix} Y_i'Z(Z'Z)^{-1}Z'y_i \\ X_i'y_i \end{bmatrix}$$

It has been suggested[26] that the principal components should be calculated from the matrix X that is the matrix of the predetermined variables occuring in the whole system[27]. The number K of the retained principal components should be at least equal to G_i the number of explanatory endogenous variables so that identifiability can be ensured.

FOOTNOTES TO CHAPTER TWO

1. The exposition of econometric theory mainly follows J. Johnston, Econometric Methods, 1972.

2. The second order condition for the minimization of (e'e) is satisfied as the matrix (X'X) is positive definite: R.S. Pindyck and D.L. Rubinfeld, Econometric Models and Economic Forecasts, 1981, p.101.

3. Johnston, op. cit.

4. A.C. Harvey, The Econometric Analysis of Time Series, 1981, p.84.

5. Pindyck and Rubinfeld, op. cit., p.71.

6. For a brief exposition of this test, see G.G. Judge, W.E. Griffiths, R. Carter Hill and Tsoung-Chao Lee, The Theory and Practice of Econometrics, 1980, pp. 460-462.

7. Judge et al., op. cit.

8. Johnston, op. cit., pp 163-164.

9. D.A. Belsley, E. Kuh and R.E. Welsch, Regression Diagnostics: Identifying Influential Data and Sources of Collinearity, 1980.

10. Belsley et al., op. cit., p.99.

11. Belsley et al., op. cit., p.113.

12. Johnston op. cit., p.245.

13. Johnston, op. cit., p. 305.

14. Harvey, op. cit., p.225.

15. Pindyck and Rubinfeld, op. cit.

16. Johnston, op. cit.

17. Johnston, op. cit., p.354.

18. The exposition of factor analysis follows mainly H.H. Harman, Modern Factor Analysis, 1976.

19. Harman, op. cit., p.135.

20. The number of side conditions equals the number of elements of a triangular correlation matrix of order n.

21. Harman, op. cit., p.140.

22. In the case of orthogonal factors pattern and structure matrices are identical.

23. Harman, op. cit., p.266.

24. Harman, op. cit., p.290.

25. T. Kloeck and L.B.M. Mennes, "Simultaneous Equation Estimation Based on Principal Components of Predetermined Variables", Econometrica, 28(1960).

26. Kloeck and Mennes, op. cit.

27. When the principal components are calculated from the matrix of all the predetermined variables X the 2SLS estimator (2.8.47) is consistent: M.D. McCarthy, "Notes on the Selection of Instruments For Two Stage Least Squares and K Class Type of Estimators of Large Models', University of Pennsylvania, Department of Economics, Revised Discussion Paper No. 125.

3. CONSUMPTION EXPENDITURE

3.1 Consumption Expenditure Increase

In Greece consumption expenditure in real terms, during the period 1954-1977 accounts, on the average, for over 70% of gross real national product at market prices. Since the structure of the expenditure has, certainly, a major role to play in the way economy is evolving through time, the analysis of consumption expenditure is the subject of extensive analysis.

Before starting the discussion of the results of this analysis some information will be given, in very broad aggregate terms, concerning the structure and evolution, during this period, (1954-1977) of consumption expenditure, the prices of its different categories, and savings.

National consumption expenditure, which includes the expenditure of Greeks abroad but excludes foreigners expenditure in Greece(1), reached from 81.9 in 1954 the figure of 295.3 billions in 1977 which amounts to an average increase of 5.5% per annum in constant 1970 prices. In the same period the real gross national product at market prices from 102.7 billion drs reached 431.1 billions, an average annual rate of growth of 6.2%, while real disposable income, the measure of purchasing power of the population, from 72.6 billion drs in 1954 growing by an average annual rate of 6.6% was in 1977 at the amount of 340.3 billion drs in real terms (deflated by the consumer price index).

Real savings at the same time, measured as the difference between disposable income and national consumption expenditure and deflated by the consumer price index, from 6.9 billion drs in 1956 were, at the end of the sample period in 1977, at the amount of 60.4 billion drs an average rate of growth of 10.3% per annum, as Tables 3.1 and 3.2 show (Appendix 1).

Splitting rather arbitrarily the whole sample period 1954-1977 in smaller periods, consisting of some five years each and four years for the last one, we can find out, as can be seen in Table 3.3 (Appendix 1) that a non-uniform pattern of growth of real savings existed, as it might be expected, throughout this period. At the beginning following an accelerating pace of increase, savings reached an average rate of growth of 33% up to 1963, followed by a lower rate of 7% during the 1964-1968 period. After this decline in their growth rate, real savings increased at a rate of 19.5% for the next five years, closing, in the last interval of the sample period of crisis following world events (oil crisis), with a low average rate of only 2.6%.

During the same period the ratio of real savings to real disposable income starting from a very low percentage at the beginning of the period under study, reached a figure of 11.6% in 1964. The next decade was characterised, in the first years, by a slower rate of increase in the ratio of savings to disposable income, but accelerating during the end of the period, to its peak of 23.7% in 1973. But the ratio declined over the next four years 1974-1977 to an average figure around 18% reflecting probably the fact that the accelerating inflation of this years and consequently the increased uncertainty induced a higher expenditure.

For the needs of the present study and as frequently is done in empirical research, total domestic consumption was split into three categories, those of consumption of non-durables, consumption of services and consumption expenditure on durable goods, the latter including as well the category of semi-durable[2] goods as they are presented in the national accounts of Greece.

Table 3.1 (Appendix 1) shows the composition of total private domestic consumption expenditure with respect to the three categories of consumption expenditure mentioned above, and the way they developed during the time period undertaken under this study.

Total private domestic consumption expenditure in real terms grew in 1954-1977 at an average rate of 5.6% annually, while real consumption of non-durables, growing at an average annual rate of 4.3%, was a steadily declining proportion comprising 60.2% of total consumption in 1954 and 44.1% at the end of the sample period in 1977. This is an expected result as the economy develops, with incomes and living standards rising and the population having satisfied, at least to some extent, basic needs turning to purchasing luxurious goods and pursuing more sophisticated ways of life, switching expenditure proportionately more to durable goods and services.

Despite the fact that in the same period the average annual rate of growth of expenditure on services was a little higher than the corresponding figure for total consumption - 5.9% and 5.6% respectively - the proportion of services in total consumptio expenditure grew at a very low rate, bringing that proportion from 29.4% in 1954 to 31.1% in 1977 as is presented in detail in Table 3.1, which shows that expenditure during the sample years switched mainly to durable goods.

The expenditure on durables (including semi-durables as mentioned above) was growing at a rate of 9.5% per annum, considerably faster than the other two categories, and brought the ratio of durables to total consumption from a figure of 10.4% in 1954 to almost a quarter of total expenditure, the figure standing at 24.8%.

Expenditure on durables in real terms shows an almost ninefold increase, from 8.6 billion drs in the beginning of sample period to 76.3 billion drs in 1977 (see Table 3.1).

In addition to higher income, changing tastes and influences from different patterns and ways of life, which have contributed one way or another in this considerable increase in the expenditure on durable goods, another factor which may have sustained that trend is the influence of durable prices and especially its relation to the consumer price index and to the prices of the other two consumption categories. These consumption categories prices are their implicit deflators, calculated as the ratio of the nominal over the real expenditure for each category. (The base year is 1970.)

The consumer price index shows (Table 3.4, in Appendix 1) a slow rate of increase in the early years of the sample period, followed from the early 70's by a rapidly accelerating pace of inflation culminating in an average figure of 4.9% for the whole period under study. While, from the three implicit deflators which present a similar pattern of evolution, only the durable ones has a lower rate of 4.5% per annum, the corresponding figures for the implicit deflators for non-durables consumption and services being at 5.5% and 5.2% respectively.

The fact of a lower rate of increase in the deflator for durable goods and its possible influence in the development of different patterns of expenditure rates between the three categories, is better reflected in the movement and rates of change in the relative price indices constructed by dividing the implicit deflator of each consumption group by the consumer price index.

The relative price for consumption of non-durables shows a rate of increase of about 0.7% per year, while that of services is a more modest annual one of around 0.3%, and on the contrary, the relative price index for durable goods was declining steadily over the years 1954-1977 by an average of -0.4%, giving support to the argument that relative prices may exercise an independent influence on consumption expenditures.

3.2 Problems with the Utility Approach

The framework of demand functions for different goods based on utility theory could be in addition to other considerations, more appropriate in the study of the effects of relative prices, but this research is conducted in the context of income theories of consumption.

The demand functions are derived from the first order conditions of the maximization of a specified a priori utility function subject to a budget or total expenditure constraint. The properties of the utility function and the first order conditions determine the functional form of the demand equations and the restrictions of the parameters across demand equations. Thoug these advantages could not be disregarded, there were some reasons weighing against the utility approach (apart from the considerable estimation problems).

It can be argued that for Greece during the sample period the basic assumption of a demand system concerning the existence of a stable aggregate utility function cannot be supported.

During this period a lot of tremendous changes have occurred in the country, concerning economic magnitudes, tastes, social groups and attitudes and demographic movements. In the early fifties the country emerged devastated from the effects of a prolonged period of wars (Second World War followed by Civil War) and was confronted with the immense problems of reconstruction.

The pursued policies were directed to secure a high rate of growth of the economy so that not only the immediate needs could be satisfied but also the transformation of the structure of the economy could advance. Measures were taken to expand the industrial sector and to modernize agriculture. The country also developed its relations and the cooperation with other countries, while its links with the more advanced and industrialised western countries were particularly strengthened. The economic growth achieved and the closer relations with other countries, through trade, tourism and cultural contacts has resulted in important changes. Standards of living were improved, the consumption not only increased but its pattern also transformed. New goods (especially of the durable category) were introduced of greater variety and higher quality and new styles were established. The contact with new ideas has also contributed and intensified the change in tastes and attitudes, while the economic expansion gave also prominence to different social groups with an influence on the way society evolves.

Findings from empirical research suggest that demographic factors such as family size and composition, head of the family, location of residence and others, play an important role in consumption, and differences in the expenditure patterns arising from such factors probably indicate underlying changes in tastes for different social groups. As can be seen in Table3.5 there are demographic changes such as the fall in the younger groups as a percentage of total population and the significant increase in emmigration. In addition the location of residence of families has sharply changed as vast numbers of people moved to urban areas brining their share in the population from 37.7% in the 1951 census to 53.2% in the 1971 one (Table 3.5, Appendix 1).

These demographic movements, intermingled with economic and social ones, like growth and rising incomes, and accompanied by factors contributing to the change of life styles, have led to the acceptance and acquisition, at an increasing rate, of superior and altogether new goods. All these influences combined, have certainly contributed in altering the parameters of the aggregate utility function if not its functional form as the introduction of new goods causes problems in a conventional utility function context. The problem becomes even more difficult with durables(3), in trying to measure the services which provide for people and to find out the flow of these services and the stock and the rate of purchase of these goods over time in such a way, as to maximize utility.

Because of these considerations and as the main aim is the determination of the income-expenditure relationship, the analysis is based, as it was mentioned earlier, in the traditional macroeconomic approach, that is in the theoretical framework of explaining consumption expenditure through the influence, mainly, of income and wealth.

Consumption expenditure, as it is already mentioned, has been disaggregated on the basis of durability into expenditure on non-durables, services and durables (semi-durables included in the last category).

Apart from the well established principle of dividing consumption expenditures into these three categories, another factor that prompted the use of that grouping in the present work (instead of using an aggregate consumption function), is the way these three categories have been developing during the sample period. As it has been already mentioned the consumption of non-durables has been declining over the years 1954-1977, while expenditure on services is almost a constant proportion of total consumption expenditure (Tables 3.1 and 3.3 in Appendix 1).

On the other hand consumption of durables and semi-durables has been growing at higher rates constituting a larger proportion of total consumption. Durables and semi-durables were grouped together despite differences in durability between them, because of the importance of this characteristic in determining the pattern of their expenditure. It is considered that the differences between consumption categories would not affect in a similar manner the way perceptions about income changes are formed and more importantly the length of the average consumption lag, for each type of consumption expenditure, both of which are of considerable importance and the use of an aggregate consumption function would have concealed them.

Consumption of durables is measured by the expenditure on their purchase in any year and not by the imputed value of the services provided from their stocks which, though theoretically more sound, despite some objections(4), is very difficult to implement as virtually no information is available concerning the value of the existing stock of durables each year.

Before turning to a brief exposition of consumption theories based on income and wealth, it should be mentioned that in this study variables entering into consumption functions are not expressed in per capita terms (deflated by population figures), as the rate of increase of the population during 1954-1977 is very small averaging only 0.7% per annum.

3.3 Income-wealth Consumption Theories

As a meaningful evaluation of the results of empirical research is fruitful only when they are placed in a theoretical context, some of the many theories and models, which developed to explain consumption expenditure or parts of it, will be summarised.

a. Absolute income hypothesis

The concept of the aggregate consumption function originated in the work of J. M. Keynes(5). Keynes was mainly concerned with macroeconomic problems such as business fluctuations, employment and the determination of effective demand (the sum of consumption and investment).

According to Keynes consumption expenditures depend on the level of income and people on the average increase their consumption as their income increases, but not by as much as their income increase (i.e. the marginal propensity to consume (mpc) is less than one). He went on to put forward the proposition that the long run marginal propensity to consume (mpc) is less than the average propensity to consume.

To test this hypothesis and to determine the relation between income and consumption a lot of empirical work(6) has been carried out at the aggregate level. The results from short-run studies appear to confirm the absolute income hypothesis as the current income explained most of the variability in consumption and the marginal propensity to consume was less than the average. But the stability of the aggregate consumption function was more problematic as its parameters were sensitive to the addition of other variables. But the main shortcoming of the absolute income hypothesis was its inability to explain the long run constancy of the average propensity to consume out of income. Kuznets in his empirical work has shown that in the USA from 1870 the ratio of consumption to national income has remained constant despite the fact that income increased many times. In addition cross-section studies found that as income rises the average propensity declined. To explain this apparent contradiction many theories have been proposed.

b. <u>Relative income hypothesis</u>

The main argument of the relative income hypothesis is that the individual's rate of consumption depends not on the level of his income but on his relative position in the scale of income distribution. Duesenberry, one of the main proponents of the relative income hypothesis, argued on psychological grounds that people are motivated by emulating others and that they endeavour to achieve higher standards of living which, once attained, they try to maintain even when their income is falling.

In the case of the individual, it is argued that relative income is his current real income over the average income of the group of which he believes he is a member. On the aggregate level Duesenberry argues that the relative income can be expressed as the ratio of current income over the highest income previously reached. The theory also suggests, appealing mainly to psychological factors, that the relation between income and consumption is one of proportionality, that is in the long run the consumption income ratio is invariant to the secular growth in income.

A version of this theory has substituted for peak income by the previous peak consumption, arguing that people are attached to consumption patterns. Both versions for developing economies, which have experienced for many years a continuous growth in income and consumption, came to use previous period income or consumption as the previously highest attained ones.

Both these theories, the absolute and relative income hypotheses, maintain that current income or its ratio to the highest previously attained, is the main determinants of consumption expenditure. But from observation it is apparent that there are social groups, like entrepreneurs, who have stable consumption expenditure while their incomes vary considerably from period to period. This point serves to suggest that some people do not base their expenditure on the income they receive at the current period but that they plan their consumption expenditure and that those plans are based on the expected income yielded from the total of their resources, human and non-human, over the whole of their life. Basically two theories have been independently developed along these lines, the permanent income and the life cycle hypotheses.

c. Permanent income hypothesis

The essential idea of the permanent income theory, proposed by M. Friedman, is to explain consumption expenditure on the basis of the income streams a consumer expects to receive from his wealth over his lifetime. Consumption is redefined as the flow of services derived from purchases and divided into two parts labelled permanent and transitory, permanent consumption each period being part of the consumer unit long run plan. Income is also divided into permanent and transitory components, the permanent income component depending on each consumer's wealth and the rate of return at which this wealth is discounted. A further assumption of the permanent income hypothesis is that no correlation exists between permanent and transitory income, between permanent and transitory consumption or between transitory income and transitory consumption.

Formally the hypothesis is stated as

3.3.1 $C_p = K(i,w,u)\ Y_p$

3.3.2 $Y = Y_p + Y_t$

3.3.3 $C = C_p + C_t$

3.3.4 $\rho_{Y_tY_p} = \rho_{C_tC_p} = \rho_{Y_tC_t} = 0$

where C_p is permanent consumption, K is a factor of proportionality between permanent income (Y_p) and permanent consumption, i, is the interest rate, w the ratio of non-human wealth to income and u the variable which includes the effects of such factors as consumer's tastes, age, family composition. Y and C are measured income and consumption respectively and Y_t and C_t their corresponding transitory components.

Equations (3.3.2) and (3.3.3) define the connection between measured income and consumption and the permanent and transitory components of these magnitudes. In equation (3.3.4) ρ is the correlation coefficient between the subscripted variables.

The permanent income hypothesis in equation (3.3.1) states that permanent consumption is a multiple K of permanent income. Their ratio is independent of permanent income but K, the factor of proportionality between them, depends on other variables (7), in particular the rate or set of rates of interest (i) at which consumers can borrow or lend, the relative importance of property and non-property income, symbolised by the variable (w), the ratio of non-human wealth to income, and the variable (u) which stands for the effects of age, household size, tastes and preferences for consumption. Permanent consumption according to Friedman can be fairly well approximated by measured consumption, but for the approximation of permanent income, also unobservable, several methods have been proposed. The most commonly used method, which is also employed in this work, is to approximate permanent income by a weighted average of present and past values of measured income, usually employing a distributed lag with geometrically declining weights b_i formed as $(1-\lambda)\lambda^i$ $(o < \lambda < 1)$. The permanent income hypothesis has been widely accepted and contributed in the explanation of economic behaviour such as the consistency of the aggregate marginal propensity to consume over the years while income was rising. But some of the basic tenants of permanent income hypothesis have not been corroborated, but indeed refuted in a number of empirical works. There is mixed evidence concerning the postulate that the permanent income elasticity of consumption is unity. Studies have found that transitory income exercises a positive effect on consumption contrary to what this theory assumes. It is also clear that lag effects on consumption are shorter than those found by Friendman(8).

d. Life Cycle Hypothesis

The life cycle hypothesis is very similar to the permanent income hypothesis but it has been advanced independently by Modigliani, Brumberg and Ando. It also divides income in permanent and transitory components. Both hypotheses define consumption in the same way and share the proportionality assumption that the allocation of consumption over time is independent of the level of income, although life cycle hypothesis does not consider it as basic tenet. On the other hand the life cycle theory puts greater emphasis on the underlying utility function and on family size, assuming furthermore that households save only to finance consumption later in their life and do not intend to pass their wealth to their heirs, so they consume all their assets over their life time.

Modigliani and Brumberg start(9) from the individual consumer utility function, assumed to be a function of current and future consumption. The consumer tries to maximize his utility subject to the resources available to him, being the sum of current and discounted future earnings over his life time plus his current net worth. Under these assumptions, they postulate that the total consumption at time t of a person of age T will be proportional to the present value of his total resources that is

3.3.5 $$C_t^T = \Omega_t^T V_t^T$$

Ω_t^T is the factor of proportionality depending on the form of the utility function, the rate of return on assets and the age of the consumer.

Furthermore they express the present value of the resources V_t as

3.3.6 $$V_t = A_{t-1}^T + Y_t^T + \sum_{\tau=T+1}^{N} \frac{Y_t^{eT}{}_\tau}{(1+r_t)^{\tau-T}}$$

where A_{t-1}^T is the net worth of a consumer age T in the previous period Y_t^T stands for current non-property income, $Y_t^{eT}{}_\tau$ is the expected non-property income and N the time horizon of the consumer of age T.

After defining expected non-property income as

3.3.7 $$Y_t^{eT} = \frac{1}{N-T} \sum_{\tau=T+1}^{N} \frac{Y_t^{eT}{}_\tau}{(1+r_t)^{\tau-T}}$$

and aggregating individual's consumption function in each age group they derived the consumption function for the age T group as

3.3.8 $$C_t^T = \Omega_t^T Y_t^T + \Omega_t^T (N-T) Y_t^{eT} + \Omega_t^T A_{t-1}^T$$

And the community's consumption function after summation over all age groups is given as

3.3.9 $$C_t = a_1 Y_t + a_2 Y_t^e + a_3 A_{t-1}$$

As expected non-property income Y_t^e is unobservable and employing the naive hypothesis that it is proportionate to measured income that is

3.3.10 $$Y_t^e = bY_t$$

the aggregate consumption function under life cycle hypothesis becomes

3.3.11 $$C_t = (a_1 + a_2 b) Y_t + a_3 A_{t-1}$$

that is a function of current measured income and the community's previous period net worth.

In the life cycle hypothesis an implication of its assumptions, which also constitutes a significant difference from permanent income hypothesis, is the possibility for an individual to consume out of transitory income, this being so because households plan to run down their assets at the end of their life time horizon.

e. Stock adjustment models

Economic behaviour in general and consumption behaviour in particular can be considered as a process of adjustment to new conditions one is obliged to face. But adjustment because of lack of information and inertia takes time. Besides, people are heavily influenced by tastes acquired and habits formed because of continuous conditioning through time. This line of explanation of consumption patterns led to the inclusion in consumption functions of the value of the previous period consumption to account for the effect of habit formation(10).

Another reason for the lagged reaction of people is the durability of some consumption goods. The effect of this property is that if a consumer buys a durable good this period, he is unlikely to purchase the same good the next period.

This line of explaining consumer behaviour led to the inclusion of the stocks of durables in the consumption functions to account for the cyclical component in their expenditure.

It is postulated that an equilibrium (desired) level of stock of durable goods exists and when it is attained consumers do not increase or diminish it(11). Hence as long as the actual stock is less than the equilibrium level the consumers will try to fill the gap buying more goods and increasing their stocks. On the other hand when the actual stock exceeds the equilibrium level it will be diminished but the reduction cannot be greater than the amount used up (depreciation rate). It is furthermore assumed that, when actual stock is less than its desired level, consumers cannot fill the gap between them in one only period but only partially by a proportion of it.

The simplest form of a partial adjustment model[12] is as follows:

3.3.12 $S_t - S_{t-1} = k(S_t^* - S_{t-1})$ with $0 < k < 1$ where S_t and S_{t-1} are actual stock of durable goods at time t and t-1, S_t^* the desired or equilibrium level of stocks and k the adjustment coefficient which shows the proportion by which the gap between actual and desired stocks is reduced in period t.

Then expenditure is separated into two components that is expenditure (a) to increase the stock of durables by the amount $k(S_t^* - S_{t-1})$ and (b) to replace the proportion of stocks depreciated in the previous period.

Consequently annual expenditure for durables is

3.3.13 $C_t = k(S_t^* - S_{t-1}) + \lambda S_{t-1}$ where λ is the constant annual depreciation rate. Postulating that the desired level of stock S_t^* is a linear function positive in income and negative in prices we have

3.3.14 $$S_t^* = a_o + a_1 Y_t + a_2 P_t + u_t$$

Substitution of (3.3.14) to (3.3.13) leads to the equation

3.3.15 $$C_t = a_o k + a_1 k Y_t + a_2 k P_t - (k-\lambda) S_{t-1} + k\, u_t$$

This model has the serious defect of not allowing depreciation during the current year especially for goods like clothing which are durables with a short life. In addition the final equation (3.3.15) contains the stock variable for which it is extremely difficult to obtain, if at all, reliable data. But another formulation of stock adjustment models, proposed originally by Stone and Rowe (1957) avoids both these difficulties(12a). In a simplified exposition(13) the model consists of three equations

3.3.16 $$S_t^* = a_o + a_1 Y_t + a_2 P_t + u_t$$

3.3.17 $$S_t - S_{t-1} = C_t - b_1 S_t - b_2 C_t$$

3.3.18 $$S_t - S_{t-1} = k(S_t^* - S_t) \quad \text{and } 0 < k < 1$$

Equation (3.3.16) defines the unobservable variable of desired stocks for the sake of simplicity, as a function of income and prices only. In equation (3.3.17) the change in stocks is related to expenditure for the good in question at the current period and to depreciation rates b_1 and b_2 out of stock (S_t) and current purchases. Finally equation (3.3.18) is the stock adjustment process which shows that actual stocks are adjusted partially by a proportion k to the desired stocks S_t^*.

After the appropriate substitutions and algebraic manipulations it can be shown that, omitting the error term, the equation explaining the consumption of that particular durable good is

3.3.19 $$\Delta C_t = \frac{b_1 k a_o}{1-b_2} - kC_t + \frac{b_1 k a_1}{1-b_2} Y_t + \frac{k a_1}{1-b_2} \Delta Y_t + \frac{b_1 k a_2}{1-b_2} P_t + \frac{k a_2}{1-b_2} \Delta P_t$$

as can be seen the variable C_t enters the equation with a negative coefficient. The above model has the same reduced form of (3.3.19) as the following formulation which generalises the concept of stocks for other consumption goods in apart for durables.

The idea of the influence of stocks and habits on consumers purchases for all goods has been combined in a single model by Houthakker and Taylor. This was done by interpreting the stock variable (S_t) as a psychological stock of habits having a positive effect on current purchases. Thus if for example a person begins smoking cigarettes he will develop a habit and hence will tend to increase the consumption of cigarettes. The stock adjustment procedure to all goods has been implemented by Houthakker and Taylor(14) in their work "Consumer Demand in USA".

They begin the analysis with the hypothesis that current demand for a commodity is a function of current and past values of the variables that determine consumption purchases which are reflected in the current stock of the commodity (stock interpreted as including habits as well). Leaving aside for simplicity prices and other variables which could affect purchases, a simple form of consumption function is postulated as

3.3.20 $\quad C_t = a + bS_t + cY_t + u_t$

where C_t are purchases of a good at time t, Y_t income at time t and S_t the existing stock of the good at the current period.

They proceed to eliminate the stock variable in equation (3.3.20) by using the identity

3.3.21 $\quad \dot{S}_t = C_t - \delta S_t$

where $\dot{S}_t$ is the rate of change in the stock variable and δ a constant rate of depreciation.

After repeated substitutions and algebraic manipulations (which will be given in detail in Section 3.5) they finally arrive at the equation

3.3.22 $\quad \dot{C}_t + a\delta + (b-\delta)\ C_t + c\dot{Y}_t + c\delta Y_t$

which relates the rate of change of the expenditure for each commodity to the level of its expenditure, the level of current income and its rate of change and in which the unobservable variable S_t has been eliminated. The application of the model has provided support for this hypothesis and demonstrated the importance of stocks in explaining consumption expenditure.

3.4 The Empirical Results

Most of the aforementioned theories maintain that the main influence on consumption expenditure comes from income whether in the form of permanent or any similar concept. But in empirical applications all the different forms of income concepts are approximated by measured income itself, or magnitudes calculated on its basis. At the same time much of the theoretical and empirical work on consumption has conclusively demonstrated that expenditure on goods and services is better explained, if income influences are viewed in a dynamic context. Different phenomena could cause the effect of income on consumption to be felt over several time periods. For example if people base their estimates concerning expected income on the basis of previous measured income then consumption will be a function of current and lagged incomes,their effects plausibly declining over time.

On the other hand people may change their habits and customs formed by consumption experience very slowly so that the effects from changes in income may be spread over a long period. At the end these assumptions concerning consumers behaviour reduce to the inclusion of lagged consumption in the estimated equations. Other formulations can also dynamise consumption functions by including in the equations lagged expenditure, like the stock adjustment process or the effects of transitory income(15).

Over the years the permanent income hypothesis has been widely accepted as leading to meaningful explanation of consumption expenditure, but on the other hand specific postulates of it have not received much support from empirical tests, such as the assumptions of proportionality and of zero effect out of transitory income, while the length of the consumption lag remains controversial(16).

It is in the line of a broad interpretation of the permanent income hypothesis that the results of this study should be seen. While future expected income has an important role to play in explaining consumption, the proposition that consumers plan their expenditure over their life time may not be very valid as some necessary assumptions, like perfect or at least adequate foresight may not hold(17). Especially for countries as yet not fully developed, which have started from low income levels and undergone a lot of changes (like Greece during the sample period), people may not have adequate knowledge about future incomes and the influence of current income on consumption could be greater than that of previous periods. Later as the economy develops and rising incomes follow a more stable path, it has been argued that consumption could be better organised(18) and the importance of current income may diminish.

The consumption functions estimated in this work are of the dynamic form as lagged expenditure has been included in the estimated equations, rationalized in the context of that broad interpretation of permanent income hypothesis. The case of habit formation has been tested separately by estimating a version of the main model in the line suggested by Zellner et al.[19].

3.4.1 <u>The effect of expected income</u>

It can be postulated by a simple interpretation of the permanent income hypothesis, that people decide the level of their consumption expenditure based on the income they expect to receive over several periods ahead. Taking into consideration that the proportionality assumption of permanent income theory has not been confirmed by a large number of empirical research[20] the relationship between consumption and expected income can be approximated by a linear function formed as:

3.4.1.1 $$C_t = a_o + a_1 Y_t^e + u_t$$

where C_t is real consumption expenditure, Y_t^e the real expected income and u_t the error term having the required properties. Expectations are assumed to follow a simple adaptive process of the form[21]:

3.4.1.2 $$Y_t^e - Y_{t-1}^e = (1-\lambda) \left[Y_t - Y_{t-1}^e\right] \qquad \text{and } 0 < \lambda \leq 1$$

the variable Y_t being real measured income.

The behavioural assumption (3.4.1.2) implies that people adjust the difference in expected incomes of two successive periods by a percentage $(1-\lambda)$ of the gap between the measured current income and the previous period's expected one.

Solving (3.4.1.2) with respect to Y_t^e we get:

$$3.4.1.3 \qquad Y_t^e = (1-\lambda)Y_t + \lambda Y_{t-1}^e$$

lagging (3.4.1.3) by one period and substituting for Y_{t-1}^e it is found that:

$$3.4.1.4 \qquad Y_t^e = (1-\lambda)Y_t + (1-\lambda)\lambda Y_{t-1} + \lambda^2 Y_{t-2}^e$$

lagging repeatedly (3.4.1.3) and substituting into (3.4.1.4) for the resulting lagged expected income the following equation is finally derived:

$$3.4.1.5 \qquad Y_t^e = (1-\lambda)\left[Y_t + \lambda Y_{t-1} + \lambda^2 Y_{t-2} + \ldots + \lambda^n Y_{t-n} + \ldots\right] \quad \text{or}$$

$$3.4.1.6 \qquad Y_t^e = (1-\lambda)\sum_{i=0}^{\infty} \lambda^i Y_{t-i}$$ in a compact form, that is expected income is a distributed lag of current and past measured income with the weight λ declining geometrically.

Substituting equation (3.4.1.6) into (3.4.1.1) and applying the commonly used transformation proposed by Koyck(22) we arrive at the estimated form of consumption function as

$$3.4.1.7 \qquad C_t = a_o(1-\lambda) + a_1(1-\lambda)Y_t + \lambda C_{t-1} + v_t$$

where $v_t = u_t - \lambda u_{t-1}$

As it was mentioned earlier, apart from the effect of expected income on consumption, it is possible that habits exercise their own influence independently. To account for this effect[23] the lagged consumption is included in equation (3.4.1.1) thus we get

3.4.1.8 $$C_t = a_o + a_1 Y^e_t + a_2 C_{t-1} + u_t$$

By applying the same procedure as before the estimated equation can be written as

3.4.1.9 $$C_t = a_o(1-\lambda) + a_1\ (1-\lambda)Y_t + (a_2 + \lambda)\ C_{t-1} - a_2\lambda C_{t-2} + v_t$$

It should be noticed that the estimated coefficient of C_{t-2} in equation (3.4.1.9) should have as the derived equation (3.4.1.9) shows a negative sign in order for the model to be valid. Apart from this, if the coefficient is not significantly different from zero in a statistical sense, the assumption of habits formation cannot be maintained as working hypothesis.

Equation (3.4.1.9) was estimated for the period 1904-1977 for all the three consumption categories of non-durables (CND), durables (CD) and services (CS). Measured income is personal disposable income (DY)[24] and all variables are expressed in constant 1970 million drs.

Estimating equation (3.4.1.9) by ordinary least squares we get the following results (figures below the coefficients are t absolute values):

$$CND_t = \underset{(1.97)}{34124.8} + \underset{(13.90)}{0.27DY_t} + \underset{(1.12)}{0.083CND_{t-1}} + \underset{(0.27)}{0.017CND_{t-2}}$$

$R^2 = 0.99$ DW = 0.91 POS. SEE = 2601.1

$$CD_t = -\underset{(1.27)}{1922.3} + \underset{(1.77)}{0.04DY_t} + \underset{(2.70)}{0.626CD_{t-1}} + \underset{(1.27)}{0.29CD_{t-2}}$$

$R^2 = 0.99$ DW = 1.75 N.A. SEE = 1988.02

$$CS_t = \underset{(0.66)}{-5269.2} + \underset{(1.66)}{0.048DY_t} + \underset{(3.20)}{0.92CS_{t-1}} - \underset{(0.34)}{0.077CS_{t-2}}$$

$R^2 = 0.99$ DW = 1.28 INC. SEE = 1090.6

For consumption of non-durables and durables the joint hypothesis of income expectations and habit formation is rejected as in both the coefficients of CND_{t-2} and CD_{t-2} have the wrong sign (a negative sign expected a priori). In addition the coefficients in both are statistically insignificant and for consumption of non-durables it is even smaller than its standard error.

In the function for services the term CS_{t-2} has the appropriate negative sign indicated by the model (3.4.1.9), giving some weak support to the presence of habits and expectations effects while in Table3.1(Appendix 1) can be observed that expenditure on services is an almost constant proportion around 30% of total consumption. But as the coefficient of CS_{t-2} is statistically insignificant and close to zero (0.34) not much faith could be asserted that the habit-expectations hypothesis is operative in this case, an indirect evidence to pay attention to the influence of only the expected income on consumption.

The equation focusing on expected income as has already been stated is

3.4.1.7 $C_t = a_o (1-\lambda) + a_1 (1-\lambda) Y_t + \lambda C_{t-1} + v_t$ and $v_t = u_t - \lambda u_{t-1}$

The equation (3.4.1.7) was at first estimated by ordinary least squares under the assumption that v_t, the error term, is not autocorrelated, although the weaknesses of this assumption are well documented. For measured income Y_t the personal disposable income is used (the figures are calculated as it has been stated in footnote 24) and the results were the following, with figures in brackets below the coefficients being (for all results to follow) t absolute values:

3.4.1.10 $$CND_t = \underset{(5.44)}{11019.0} + \underset{(5.47)}{0.1174}DY_t + \underset{(8.72)}{0.6363}CND_{t-1}$$

$\bar{R}^2 = 0.997$ DW = 1.56 N.A. SEE = 1264.32

3.4.1.11 $$CD_t = -\underset{(1.23)}{1757.87} + \underset{(1.78)}{0.04027}DY_t + \underset{(7.95)}{0.8903}CD_{t-1}$$

$\bar{R}^2 = 0.99$ DW = 2.18 N.A. SEE = 1983.27

3.4.1.12 $$CS_t = \underset{(2.09)}{1316.47} + \underset{(3.65)}{0.065}DY_t + \underset{(9.99)}{0.774}CS_{t-1}$$

$\bar{R}^2 = 0.997$ DW = 1.11 INC. SEE = 1047.44

The results seem almost quite good satisfying the standard statistical tests concerning

a) The significance of the coefficients.

b) The goodness of fit using the adjusted for degrees of freedom coefficient of $\bar{R}^2$ and

c) The absence of autocorrelation is indicated by the Durbin-Watson statistic, although this should be viewed with caution because of the inclusion of the lagged dependent variable which bias the value of the DW statistic towards 2 (the value to which the DW statistic tends when autocorrelation is zero).

In the equation for durables (3.4.1.11) the coefficient of disposable income is significant when a one tail student t test of significance is applied. Moreover the influence of current income is smaller in comparison with past incomes, represented by the coefficient of lagged dependent variable, which is expected for this kind of expenditure. But the implied mean lag[(25)] is more than eight years which is probably quite long if one takes into consideration that expenditure on semi-durables is included in this category as well.

As consumption expenditures and income are part of a larger model and they are determined simultaneously, there may be the possibility of a significant simultaneity error rendering the estimated coefficients biased and inconsistent[(26)].

To account for that error and because the consumption functions (as all the equations in the model) are overidentified as the application of the order condition for identification indicates, (that is the number of excluded predetermined variables from these equations is greater than the number of included endogenous variables minus 1) they were estimated by a version of TSLS based in the use of principal components for the predetermined variables in the whole model[27].

In the first stage of the estimation among the instruments used there are four orthogonally rotated principal components of the predetermined variables. The results of the application of the described version of TSLS are:

$$3.4.1.13 \quad CND_t = \underset{(5.38)}{12204.9} + \underset{(5.36)}{0.132}DY_t + \underset{(7.04)}{0.5875}CND_{t-1}$$

DW = 1.33 INC. SEE = 1279.14

$$3.4.1.14 \quad CD_t = -\underset{(1.05)}{1521.22} + \underset{(1.51)}{0.03487}DY_t + \underset{(8.04)}{0.918}CD_{t-1}$$

DW = 2.27 N.A. SEE = 1986.30

$$3.4.1.15 \quad CS_t = \underset{(2.18)}{1387.90} + \underset{(3.92)}{0.0731}DY_t + \underset{(9.28)}{0.743}CS_{t-1}$$

DW = 1.07 INC. SEE = 1051.93

(In the case of TSLS the statistical tests, as the t test, hold asymptotically.) Compared with the results of equations (3.4.1.10), (3.4.1.11) and (3.4.1.12) estimated by ordinary least squares, the estimates derived from TSLS do not differ substantially as the following analysis show. In all equations the standard error of the regression is almost the same in magnitude. In the equations for non-durables and services the coefficients of income increased while those of lagged dependent variable decreased implying a greater dependence of expenditures on current income. But for durables the results turned to the opposite direction. The coefficient of disposable income is statistically insignificant even in one tail t test (at 5 percent level) and the implied mean lag seems implausible as now it exceeds 11 years. It should be pointed that there is a possibility that the estimates from TSLS may not be very reliable because of the applied procedure and the rather limited number of degrees of freedom.

Another alarming feature of the results of the TSLS estimation, due to its serious consequences, is the low magnitude of the Durbin-Watson statistic not only for services as with OLS estimates but for non-durables as well. Both are in the inconclusive region indicating that serial correlation may exist, which in the present case, as the results of TSLS showed, is more serious than simultaneity error.

As it has been stated earlier equations (3.4.1.7) was estimated under the strong assumption that the error term $v_t = u_t - \lambda u_{t-1}$ is not autocorrelated.

Absence of autocorrelation is important for the efficiency of the estimates as, otherwise, the standard errors would be of doubtful validity. As it is already clear the function of consumption of services whether estimated by OLS or TSLS and that of non-durables when estimated by TSLS failed the Durbin-Watson test signifying the presence of autocorrelation. Apart from these considerations, all the three consumption functions include among the regressors the lagged dependent variable whose presence, as it is well known, invalidates the application of Durbin-Watson statistic derived for non-stochastic regressors and renders the parameters estimates biased and inconsistent. This result from the violation of the assumption E $(v_t C_{t-1}) = 0$ of the linear model (that is, since C_t depends on u_t, C_{t-1} will depend on u_{t-1} but because of the relation $v_t = u_t - \lambda u_{t-1}$, u_t and u_{t-1} are not independent and consequently C_{t-1} is related to u_t and hence the assumption E $(v_t C_{t-1})$ is not satisfied resulting in biased and inconsistent estimates of the parameters). As the consequences of serial correlation are severe, equation (3.4.1.7) was re-estimated for all consumption categories by incorporating a first order autocorrelation scheme as

3.4.1.7 $\quad C_t = a_o(1-\lambda) + a_1\ (1-\lambda)\ Y_t + \lambda C_{t-1} + v_t$ and

3.4.1.16 $\quad v_t = p v_{t-1} + \varepsilon_t$

where p is the autocorrelation coefficient $(-1 \leq p \leq 1)$ and ε_t is a random non autocorrelated error with zero mean and constant variance σ^2 for all periods.

Then the consumption functions were estimated by generalised least squares (GLS) in two stages[(28)]. First a procedure devised by Hildreth-Lu[(29)] employed scanning for values of p between -1 and 1 at 0.05 intervals in an effort to avoid a local minimum. At the second stage the value of p, which minimises the sum of square residuals in the first stage, was used as a starting value in an iterative Cohrane-Orcutt procedure to get the final value of the autocorrelation coefficient.

Below the results of the application of this two stage GLS process are presented

3.4.1.17 $CND_t = \underset{(6.04)}{14078.3} + \underset{(7.22)}{0.1515}DY_t + \underset{(7.30)}{0.519}CND_{t-1}$ $\qquad p = \underset{(2.42)}{0.4592}$

$\bar{R}^2 = 0.993$ $\qquad$ DW = 1.82 N.A. $\qquad$ SEE = 1221.56

3.4.1.18 $CD_t = -\underset{(1.06)}{1377.15} + \underset{(1.48)}{0.03056}DY_t + \underset{(9.91)}{0.939}CD_{t-1}$ $\qquad p = \underset{(0.97)}{-0.20}$

$\bar{R}^2 = 0.992$ $\qquad$ DW = 1.99 N.A. $\qquad$ SEE = 1993.27

3.4.1.19 $CS_t = \underset{(0.98)}{988.358} + \underset{(3.80)}{0.0734}DY_t + \underset{(9.19)}{0.749}CS_{t-1}$ $\qquad p = \underset{(2.28)}{0.4387}$

$\bar{R}^2 = 0.994$ $\qquad$ DW = 1.59 N.A. $\qquad$ SEE = 959.39

The use of equation (3.4.1.16) with GLS is an approximation of the error structure which will necessitate the use of non-linear estimation procedures as can be shown.

Re-writing equations (3.4.1.7) and (3.4.1.16) with the assumption for u_t we have:

3.4.1.7 $C_t = a_o\ (1-\lambda) + a_1\ (1-\lambda) + \lambda C_{t-1} + v_t$ $\qquad$ where $v_t = u_t - \lambda u_{t-1}$

3.4.1.16 $v_t = pv_{t-1} + \varepsilon_t$

Substituting for v_t in (4.1.16) we get

$$u_t - \lambda u_{t-1} = p\ (u_t - \lambda u_{t-1})_{-1} + \varepsilon_t$$

Solving for ε_t and re-arranging terms we derive the equation:

$$3.4.1.20 \quad u_t - (\lambda + p)\, u_{t-1} + p\lambda u_{t-2} = \varepsilon_t$$

Equation (3.4.1.20) shows that the true error structure of the equation (3.4.1.7) when allowance for autocorrelation is made is a non linear second order process. To remove from the equation (3.4.1.7) the autocorrelated terms, when $v_t = u_t - \lambda u_{t-1}$ is used, we proceed as follows:

$$3.4.1.7 \quad C_t = a_o\,(1-\lambda) + a_1\,(1-\lambda) + \lambda C_{t-1} + u_t - \lambda u_{t-1}$$

Lagging equation (3.4.1.7) by one period and multiplying through by p, the autocorrelation coefficient, we obtain

$$3.4.1.21 \quad pC_{t-1} = a_o\,(1-\lambda)\,p + a_1\,(1-\lambda)\,pY_{t-1} + p\lambda C_{t-2} + pu_{t-1} - p\lambda u_{t-2}$$

After subtracting (3.4.1.21) from (3.4.1.7) and rearranging terms, the derived equation is

$$3.4.1.22 \quad C_t = a_o\,(1-\lambda)(1-p) + a_1\,(1-\lambda)Y_t - a_1\,(1-\lambda)\,pY_{t-1}$$
$$+ (\lambda+p)\,C_{t-1} - p\lambda C_{t-2} + u_t - (\lambda+p)\,u_{t-1} + p\lambda u_{t-2}$$

Combining equations (3.4.1.22) and (3.4.1.20) we finally arrive at the estimated equation

$$3.4.1.23 \quad C_t = a_o\,(1-\lambda)(1-p) + a_1\,(1-\lambda)Y_t - a_1\,(1-\lambda)pY_{t-1}$$
$$+ (\lambda+p)\,C_{t-1} - p\lambda C_{t-2} + \varepsilon_t$$

Equation (3.4.1.23) has a random error satisfying the statistical assumptions and was estimated for all three consumption categories, as it is necessary, by non-linear least squares, so the non-linear restrictions on the parameters were taken into consideration.

In the Table 1 below the results of the non-linear estimation of (3.4.1.23) for the three types of consumers expenditure are presented together with those of the implied parameters (a_o, a_1) of GLS estimation of equations (3.4.1.17)(3.4.1.18) and (3.4.1.19).

The comparison shows that the GLS estimates are almost identical to those of the non linear estimation (NLLS) which takes into consideration all the restrictions in the parameters. This indicates that the GLS estimation of the equation (3.4.1.7) and (3.4.1.16) combined together produced satisfactory estimates of the parameters of the error structure.

From the GLS estimation the implied long run marginal propensity to consume out of income (a_1) and the mean lags for non-durables and services expenditures seem quite reasonable. The precise figures are 0.3151 and 1.08 years for non-durables and 0.2924 and 2.98 years for services (the figures from equations (3.4.1.17) and (3.4.1.19) respectively). But the same conclusion cannot be supported for the durables. The long run marginal propensity is larger than 0.50 which is very large, bringing the sum of the three marginal propensities to consume in excess of 1.10. In addition the mean lag for durables is very long exceeding 15 years. Even the medium lag, which shows[30] the length of time required in order for half of the adjustment of consumption to income to

TABLE 1. PARAMETER ESTIMATES FOR CND, CD AND CS BY GLS AND NON-LINEAR ESTIMATION

Parameters	CND		CD		CS	
	GLS	NLLS	GLS	NLLS	GLS	NLLS
a_o	29273.26	29272.7 (10.98)[a]	-22575.23	-23190.6 (0.86)	3937.68	3948.03 (1.02)
a_1	0.31517	0.315 (25.5)	0.50098	0.5155 (0.87)	0.29243	0.293 (10.34)
λ	0.51907	0.518 (6.81)	0.939	0.941 (8.89)	0.749	0.7506 (8.43)
p	0.4592	0.462 (2.11)	-0.20	-0.204 (0.86)	0.4387	0.4399 (1.88)
DW	1.82N.A.	1.83N.A.	1.99N.A.	1.98N.A.	1.59N.A.	1.59N.A.
SEE	1221.56	1255.02	1993.27	2047.89	959.39	985.7

(a) numbers in brackets below the coefficients are absolute t values.

be completed, is 11 years. The autocorrelation coefficients for non-durables and services show significant positive autocorrelation in the residuals, and its removal has paid off as the summary statistics show, when equations (3.4.1.10) and (3.4.1.12) are compared with those of (3.4.1.17) and (3.4.1.19). The Durbin-Watson statistic for non-durables is now 1.82 where for services from the inconclusive range moved the non-autocorrelated one. For both functions the standard error of estimate (SEE) is lower (a considerable improvement in efficiency) and it should be noted here that the GLS estimates were more efficient from those of non-linear estimation. Another notable difference is the increase in the magnitude of the income coefficient for both non-durables and services implying that a larger influence is exercised on them by current than past incomes or put it in another way the expected income is affected more by the current one, which is consistent with the situation of Greece. The country started from a low income level then experiencing a rapid growth and rising incomes, which certainly have affected the formation of income expectations[(31)], a fact which the figures in Table 3.3 (Appendix 1) could support.

For durables the autocorrelation is negative and statistically insignificant at the 5 percent level. In comparison with (3.4.1.11) the GLS estimated equation (3.4.1.18) is less efficient as the slightly higher standard error of estimate shows, leading to the conclusion that the OLS estimates are preferable if it is taken into consideration that the implied values of the long run propensity to consume (0.367) and the mean lag (around 8 years) seem more plausible.

Probably a better specification for durables as the negative autocorrelation points out[(32)] could be the inclusion of the stocks of them in the equation but the lack of the necessary data excluded that option.

As a further test, and despite the fact that it is not quite suitable for the sample, the $Z_1(k)$ statistic was calculated to test parameter stability or one period ahead forecast accuracy using the actual future values of the regressors for the next k periods. (The $Z_1(k)$ statistic is the ratio of the squared forecast error over the squared standard error of estimate over the sample period.)

A significant value of $Z_1(k)$ indicates[(33)] both an incorrect model and a change in the stochastic properties of the variables in the time data generation process of the dependent variable, whereas an insignificant value for Z_1 only shows that the latter has not occurred and it is compatible with an incorrect model.

Let f_t denote the forecast error, N the number of observations in the sample and σ the standard error of estimate of the regression, then

$$Z_1(k) = \sum_{t=N+1}^{N+k} \left(\frac{f_t}{\sigma}\right)^2$$

which is distributed in large samples as χ^2 with k degrees of freedom if the parameters in the tested equation remain constant. The $Z_1(k)$ statistic is biased[(34)] towards rejecting the null hypothesis of parameters constancy when the sample size is relatively small. (Throughout this study the 5 percent level of significance was employed for the $Z_1(k)$ statistic.) Equations (3.4.1.11) for durables estimated by OLS (3.4.1.17) and (3.4.1.19) for non-durables and services estimated by GLS were projected for the next two years for which data exist with the following results (Table 2).

The values for $Z_1(k)$ statistic are 12.569 for non-durables, 7.231 for durables and 5.763 for services while the critical value of Z_1 with two degrees of freedom is 5.992 (5% level of significance). The calculated values of Z_1 for the three consumption functions are larger than the critical value except for services which just passed the test. And although it should again be stressed that Z_1 statistic is based on the assumption of large samples the results may indicate no constancy of the parameters outside the sample period and a probable specification error. As the theory for consumption suggests that in addition to income there are other factors which influence consumers expenditure and coupled with the probable consequences arising from the values of Z_1 statistic (a significant value of Z_1

TABLE 2. FORECAST AND ACTUAL VALUES FOR CND, CD, CS 1978-79 AT CONSTANT 1970 MILLION DRS.

Years	CND			CD			CS		
	Forecast	Actual	Deviations	Forecast	Actual	Deviations	Forecast	Actual	Deviations
1978	140322	144637	4315	81017	80107	-910	100237	100944	-707
1979	148339	147951	-388	84755	79501	-5254	104886	107077	-2191
Sum of Absolute Forecast Errors			4703			6164			2898

indicates also an incorrect model, as already have been stated) led to searching for other variables relevant to consumption function as for example assets and relative prices.

3.4.2 The effect of relative prices

Microeconomic theory and empirical research have shown that prices have an important influence and are negatively related to the demand of goods. In the context of this work relative prices were introduced in consumption functions. Relative prices were constructed by dividing the price of each consumption group by the consumer price index, where as price the implicit deflators for each group were used.

The consumer price index (by which disposable income has been deflated) was used instead of the implicit deflator of total consumption, because it is generally employed to measure the cost of living (against which changes in the prices of the various goods and services are compared). It is the measure of inflation rate and thus influence wage settlements and governments transfer and social security policies.

Introducing in equation (3.4.1.1) relative prices (P_t) connected with consumption expenditure by a negative relation and using the equation of expected income formation (3.4.1.6) we derived the reduced form to be estimated as

3.4.2.1 $$C_t = a_o(1-\lambda) + a_1 (1-\lambda)Y_t + \lambda C_{t-1} - a_2 P_t + a_2 \lambda P_{t-1} + v_t$$

and $v_t = u_t - \lambda u_{t-1}$

It should be noted that the estimated equation (3.4.2.1) includes current and lagged relative prices, the former exercising a negative influence and the latter's being positive.

When the equation (3.4.2.1) was estimated for the three consumption categories the results were disappointing.

Relative prices have in all equations opposite signs to those expected, being positive for the current period price and negative for the lagged one failing to satisfy the signs of price coefficient indicated by equation (3.4.2.1). The next step was to introduce the price effect into the reduced form consumption function (3.4.1.7) and to estimate the equation

3.4.2.2 $$C_t = a_o(1-\lambda) + a_1(1-\lambda)Y_t + \lambda C_{t-1} + a_2 \frac{PC_i}{CPI} + v_t$$

$$v_t = u_t - \lambda u_{t-1}$$

$$i = 1, 2, 3$$

(where PC_i stands for PCND, PCD and PCS the implicit deflators for consumption of non-durables, durables and services respectively and CPI is the consumers price index).

For services the coefficient of prices has the wrong positive sign and it was very small and statistically insignificant so failing statistical and theoretical considerations and no further attempt was made.

The results of equation (3.4.2.2) for non-durables were mixed. The price coefficient had the correct negative sign satisfying theoretical considerations (that is, the demand for a good is negatively related to its price) but statistically was insignificant (at 5 percent level) and its magnitude less than its standard error.

As the estimation of (3.4.2.1) equation produced a significant but with the wrong sign price coefficient for non-durables, it was decided to use a price variable which could carry with it the effect of lagged prices, because to use only the lagged relative price it was considered as not appropriate for yearly data and for the types of goods included in the non-durables category.

So equation (3.4.2.2) was estimated again for non-durables and the relative price variable $\frac{PCND}{CPI}$ was successfully replaced by

a) its change between two successive years $[\frac{PCND}{CPI}_t - \frac{PCND}{CPI}_{t-1}]$,

b) its rate of change $[\frac{(PCND/CPI)_t - (PCND/CPI)_{t-1}}{(PCND/CPI)_{t-1}}]$

and last

c) by a two years smoothing average $[\frac{1}{2}(\frac{PCND}{CPI}_t + \frac{PCND}{CPI}_{t-1})]$

but all failed to produce satisfactory results, having a positive sign and being statistically insignificant[35].

As far as relative prices are concerned satisfactory results were obtained from the consumption of durables function. The OLS estimates of equation (3.4.2.2) for durables (referred to in Table 3 as (3.4.2.21) shows that the coefficient of relative price $\frac{PCD}{CPI}$ has the correct negative sign and is statistically significant (1 tail t test). The $\bar{R}^2$ was very high and the Durbin-Watson statistic showed no autocorrelation (1.91).

But as the presence of lagged dependent variable biases the Durbin-Watson statistic towards rejecting the presence of

TABLE 3. EQUATIONS FOR DURABLES WITH RELATIVE PRICES(CD)

No Equation	Procedure	Coefficients of				DW	ρ	$\bar{R}^2$	SEE
		Constant	Disposable Income	Relative Prices	Lagged Dependent				
3.4.2.21	OLS	26968.1 (1.64)*	0.0584 (2.45)	-281.6 (1.76)**	0.743 (5.49)	1.91 N.A.		0.991	1886.79
3.4.2.22	TSLS	28545.9 (1.07)	0.05707 (1.94)**	-296.26 (1.13)	0.748 (4.04)	1.93 N.A.			1887.96
3.4.2.23	GLS	29871.6 (1.54)*	0.05787 (2.13)	-307.88 (1.53)*	0.738 (5.17)	1.89 N.A.	-0.0167 (0.18)	0.990	1931.89

* insignificant in 5% level

** significant in 5% level and in 1 tail test autocorrelation and at the same time there is the problem of simultaneity error, consumption being part of a larger model, equation (3.4.2.2) for durables was estimated again by both procedures of TSLS and GLS mentioned earlier and the results are summarised in the following Table 3.

From comparisons between the equations (3.4.2.21) to (3.4.2.23) it is clear that the estimates are very close indicating that simultaneity and first order autocorrelation accounted for by the TSLS and GLS estimates are not important.

Comparing equations (3.4.1.18) and (3.4.2.23) both for durables estimated by GLS but the latter including relative prices as well, the improvement is obvious concerning autocorrelation. Its coefficient changed from -0.20 to a mere -0.0167 while the standard error of estimate decreased from 1993.27 in (3.4.1.18) to 1931.89 in (3.4.2.23) a gain in efficiency, and a further evidence of the need to include relative prices in the function for durables.

Between the equations which include relative prices (3.4.2.21) to (3.4.2.23) the one to be preferred is equation (3.4.2.21) estimated by OLS. It has a high DW statistic as the others but in addition all the variables have statistically significant coefficients (5% level) not a feature of the estimates of (3.4.2.22) and (3.4.2.23) equations and the lowest standard error of the regression of all the three as well, especially when compared with (3.4.2.23) estimated by GLS which is the least efficient estimator in this case due to the low value of the autocorrelation coefficient.

So, equation (3.4.2.21) is a good representation of the durables data, when compared with the corresponding equation without relative prices (3.4.1.1). It shows an increase by more than 40% in the magnitude of income coefficient (0.0402 and 0.0584 respectively) implying a plausible value of marginal propensity to consume of 0.227. At the same time the coefficient of lagged dependent variable decreased, lowering the implied mean lag to around 3 years compared to the lag of more than 8 years implied by the equation without relative prices (3.4.1.11).

The lower lag of 3 years seems more plausible if one takes into consideration that the consumption of durables variable contains also expenditure on semi-durables characterised by a much shorter durability. As can also be seen in Table 3.1 (Appendix 1) the percentage of expenditure on durables ranges between 23% and 37% out of the total for durables and semi-durables together, averaging around 25% between 1954 and 1977.

The preferred equation for durables (3.4.2.21) was used to forecast, as was done with equation (3.4.1.11), the value for durables for the next two years 1978 and 1979 for which data exist.

The fit outside the sample was very satisfactory. The sum of absolute forecast errors was lowered from 6164 million drs (Table 2) to 3717 million drs a considerable decrease of about 40%.

Testing finally for the constancy of the parameters outside the sample the $Z_1(k)$ statistic was calculated. Its value was $Z_1(2) = 3.507$ smaller than the critical value for χ^2 with 2 degrees which is 5.992 (at 5 percent level of significance), leading to the acceptance of the null hypothesis that the stochastic properties of the coefficients have not changed, while it should be noted that the value of $Z_1(2)$ statistic for the equation without relative prices was 7.231 well outside the critical one. The result from this test, suitable for large samples it should be again stressed, is a further evidence that equation (3.4.2.21) which satisfied also all the standard statistical tests is adequately describing the data concerning expenditure on durables[36].

3.4.3 Some different results concerning income: A diversion

Before closing the part examining the influence of income and relative prices on consumption expenditure, mention should be made of the results obtained by applying, not very systematically, other procedures to capture the effect of current and past income streams on consumption expenditure and the approximate length of its lag.

A few attempts were also made trying to find out the difference it is postulated to exist between the marginal propensity to consume out of wages and salaries on the one hand and that from other income sources on the other.

When consumption functions were estimated postulating as explanatory variable the current income, the goodness of fit measured by $\bar{R}^2$ was very high, but the value of the Durbin-Watson statistic on the other hand was very low indicating positive autocorrelation and pointing to specification error.

The inclusion of current income, and its own values lagged one period first and then two periods did not improve the results. The coefficient of current income was always significant and with the expected positive sign. The other income variables were statistically insignificant and with signs alternating, probably due to the high degree of multicollinearity between them. Apart from that the Durbin-Watson statistic was always very low showing positive autocorrelation. The same picture emerged when current income and its change between two successive years ($Y_t - Y_{t-1}$) were used as regressors.

As it has been previously discussed economic theory suggests that income streams exercise positive influence on consumption but as the time stretches to the past the impact of that influence is continuously declining, or will start declining after some few initial periods. This hypothesis leads to including anumber of income variables in the consumption functions creating a lot of problems with regard to the estimated coefficients due to the acute multicollinearity between them.

A way out of this problem is to apply the Almon scheme(37) of estimating a distributed polynomial function in income. Taking into consideration the limitation of the data, a rather arbitrary choice was made to estimate the consumption functions with a distributed lag polynomial of second degree with five period length in disposable income and without placing end restrictions as no rationale for them has been convincingly put forward.

The results for the three types of consumption expenditure were unsatisfactory. Apart from a couple of them, the income coefficients were statistically insignificant. Some have negative signs and their pattern was not always plausible (especially for equation (3.4.3.2) for consumption of durables the coefficients a_i of the income variable indicate an unlikely pattern of income expectations). In addition the Durbin-Watson statistic indicated always autocorrelation and no further attempt was made in using this approach. (In the results shown below the figures in brackets are absolute t values and st. dev. stands for standard deviations.)

3.4.3.1 $CND_t = 98216.2 - 729.204 \frac{PCND}{CPI}t + \sum_{i=0}^{4} a_i DY_{t-i}$

$R^2 = 0.99$ DW = 0.40 SEE = 2766.8

Mean lag = 0.58 years
(0.39) st. dev.

α_i

$a_o = 0.167$ (3.74)

$a_1 = 0.103$ (4.10)

$a_2 = 0.05$ (1.25)

$a_3 = 0.012$ (0.46)

$a_4 = -0.014$ (0.30)

Sum of $a_i = 0.32$
(0.033) st. dev.

3.4.3.2 $CD_t = - 6598.4 - 23.99 \frac{PCD}{CPI}t + \sum_{i=0}^{4} a_i DY_{t-i}$

$R^2 = 0.99$ DW = 1.53 INC. SEE = 1204.3

Mean lag = 2.42 years
(0.29) st. dev.

α_i

$a_o = 0.11$ (5.21)

$a_1 = -0.003$ (0.33)

$a_2 = -0.034$ (2.19)

$a_3 = 0.017$ (1.66)

$a_4 = 0.15$ (7.45)

Sum of $a_i = 0.24$
(0.0103) st. dev.

3.4.3.3 $$CS_t = -55768.3 + 598.65\,\frac{PCS}{CPI} + \sum_{i=0}^{4} a_i DY_{t-i}$$

$R^2 = 0.99$ DW = 0.77 SEE = 960.8

Mean lag = 0.99 years

a_i (0.16) st. dev.

$a_o = 0.138$ (8.60)

$a_1 = 0.06$ (7.23)

$a_2 = 0.019$ (1.34)

$a_3 = 0.009$ (1.07)

$a_4 = 0.032$ (1.90)

Sum of $a_i = 0.24$
(0.004) st. dev.

A few linear regressions were also run to determine the effect on consumption expenditures of aggregate wage and non-wage income. Wage income (WIV)is the value of wages and salaries given in Greece's national accounts. The non-wage income variable (NWYV)was constructed by subtracting from each year's national income wages and salaries and government income as well. Both income variables were then deflated by consumers price index.

The results, shown below, turned out to be erroneous with the non-wage income appearing to have a negative effect on consumption expenditures, probably because of the high degree of interelatedness between the two income variables.

3.4.3.4 $$CND_t = 42185.39 + 0.64\frac{WIV}{CPI}t - 0.017\frac{NWYV}{CPI}t$$

$\bar{R}^2 = 0.97$ DW = 0.92 SEE = 4501.1

3.4.3.5 $$CD_t = 3359.8 + 0.649\frac{WIV}{CPI}_t - 0.145\frac{NWYV}{CPI}_t$$

$\bar{R}^2 = 0.96$ DW = 0.71 SEE = 3627.6

3.4.3.6 $$CS_t = 17788.36 + 0.613\frac{WIV}{CPI}_t - 0.079\frac{NWYV}{CPI}_t$$

$\bar{R}^2 = 0.97$ DW = 0.71 SEE = 3585.6

When in addition to current one the lagged wage and non-wage income variables were included in the equations there was no improvement in the results but a few more negative signs for the non-wage income variables and the statistical significance displaced to lagged wage income instead of current one even for non-durable expenditures.

Finally as Table 3.1 (Appendix 1) reveals consumption expenditure on non-durables was declining as a percentage of total consumption expenditure while income was rising. Because of that relation between them the squared income (DY^2) was included in the equation for non-durables as a separate variable its coefficient being expected to have a negative sign to fit this pattern of relationship. The coefficient of DY^2 turned out in the estimated regressions to have the correct negative sign but its magnitude and its statistical significance were very sensitive when other variables like relative prices and the lagged dependent consumption were included in the equations which were also suspect of autocorrelation as the Durbin-Watson statistic has invariably a low value.

3.5 Application of a Model for Durables

In the Section 3.3e (stock adjustment models) a short account was given of models based on the view that economic behaviour is a continuous process of adjustment and the underlying various causes of this process include lack of information, inertia, habits and tastes and the durability of certain goods. All these different influences on expenditure were reflected on existing stocks.

Stocks are interpreted either as the formation of psychological habits having a positive influence on expenditure or as accumulation of goods having, when exceed a desired level, a negative effect on purchases, both interpretations combined together by Houthakker and Taylor as mentioned earlier.

Their model will be tested to explain consumption of durables as this sophisticated approach, that is to use stocks, is considered as having greater explanatory power from models based only on income, especially when expenditure is disaggregated to a large extent.

The detailed derivation of the estimated equation will follow the finite approximation of Houthakker-Taylor's dynamic model, suggested by J. Winder (1971)[38].

Their fundamental hypothesis is that current expenditure depends on current income and possibly other variables and the current stock of goods which consumers hold, expressed as

3.5.1 $$C_t = a + bs_t + \gamma Y_t + u_t$$

where C_t is expenditure at period t, S_t the stocks held at period t and Y_t period's t income, and b is the stock adjustment parameter being either positive showing habits influence or negative when the stock adjustment process operates (u_t is the error term).

This hypothesis for discrete time can be written as suggested by Winder as:

$$3.5.9 \qquad C_t = a + b\left(\frac{S_t + S_{t-1}}{2}\right) + \gamma Y_t + u_t$$

The stock variable can be eliminated by using the identity

$$3.5.3 \qquad \Delta S_t \equiv S_t - S_{t-1} = C_t - \delta\left(\frac{S_t + S_{t-1}}{2}\right)$$

where ΔS_t is the change in stocks and δ the constant depreciation rate.

Solving (5.2) for $\frac{S_t + S_{t-1}}{2}$ we have

$$3.5.4 \qquad \frac{S_t + S_{t-1}}{2} = \frac{1}{b}\left[C_t - a - \gamma Y_t - u_t\right]$$

substituting (3.5.4) into (3.5.3) we get that the change in stocks is expressed as:

$$3.5.5 \qquad \Delta S_t = \frac{a\delta}{b} + \frac{\gamma\delta}{b} Y_t + \frac{(b - \delta)}{b} C_t + \frac{\delta}{b} u_t$$

After first differencing (3.5.2) we derive

$$3.5.6 \qquad \Delta C_t = \gamma \Delta Y_t + b\left(\frac{\Delta S_t}{2} + \frac{\Delta S_{t-1}}{2}\right) + \Delta u_t$$

Lagging (3.5.5) and substituting for ΔS_t and ΔS_{t-1} in (3.5.6) to obtain

3.5.7 $$\Delta C_t = a\delta + \left(\frac{b-\delta}{2}\right)(C_t + C_{t-1}) + \left(1+\frac{\delta}{2}\right) Y_t - \left(1-\frac{\delta}{2}\right) Y_{t-1} + \left(1+\frac{\delta}{2}\right) u_t - \left(1-\frac{\delta}{2}\right) u_{t-1}$$

Solving C_t and replacing $Y_{t-1} = Y_t - \Delta Y_t$ we derive the estimated equation which is

3.5.8 $$C_t = \frac{a\delta}{1-(b-\delta)/2} + \frac{1+(b-\delta)/2}{1-(b-\delta)/2} C_{t-1} + \frac{\gamma\delta}{1-(b-\delta)/2} Y_t + \frac{\gamma(1-\delta/2)}{1-(b-\delta)/2} \Delta Y_t + v_t$$

where $v_t = \frac{1+\delta/2}{1-(b-\delta)/2} u_t - \frac{1-\delta/2}{1-(b-\delta)/2} u_{t-1}$

Equation (3.5.8), from which the unobservable variable of stocks has been eliminated, relates expenditure to its lagged level, the level of current income and its change. In a simplified form equation (3.5.8) can be written, if relative prices (P_t) added in equation (3.5.2) as

3.5.9 $$C_t = K_o + K_1 C_{t-1} + K_2 Y_t + K_3 \Delta Y_t - K_4 P_t - K_5 \Delta P_t + v_t$$

where K_i (i = 0, ..., 5) are the corresponding coefficients in (3.5.8) $K_4 = \frac{\delta\varepsilon}{1-(b-\delta)/2}$, $K_5 = -\frac{\varepsilon(1-\delta/2)}{1-(b-\delta)/2}$ and ε the coefficient of relative prices when included in equation (3.5.2) (the price coefficient ε, as the economic theory for the demand of goods suggests, should have a negative sign). Equation (3.5.9) was estimated with and without relative prices. In addition for each of these equations a first order autocorrelation scheme of the form $v_t = pv_{t-1} + w_t$ (w_t a random error process) was estimated by the procedure mentioned earlier.

The results, presented in the following Table 4, were futile as the coefficient K_2 has always a negative sign contrary to a positive one expected on a priori grounds (the coefficient $K_2 = \frac{\gamma\,\delta}{1 - (b-\delta)/2}$ from equation (3.5.8)). As the coefficients γ, δ and the denominator are positive the expected sign for K_2 is also positive) implying that either γ the coefficient of income in equation (3.5.2) is negative which cannot be accepted or that δ the rate of depreciation in identity (3.5.3) is negative, an absurd result.

It should be noted that models of this type have been developed and are more suitable when consumption expenditure is extensively disaggregated and its categories are more homogenous; the goods grouped together exhibit certain common characteristics so that stocks could be a more meaningful and operative concept.

On the other hand the expenditure on durables in this work is a very broad mixed category. It contains not only the commonly grouped under this label goods of rather long durability but also those usually classified as semi-durables having stocks of much shorter duration.

The latter category, constituting between 1954-77 around 75% of durables expenditure, includes goods like clothing[39] which under the influence of prevailing tastes of different social groups could be under the positive influence of habits formation[40].

TABLE 4 RESULTS OF ESTIMATION OF EQUATION (5.9) FOR DURABLES (CD)

No of Equation	Procedure	Coefficients of									
		Constant	Y_t	ΔY_t	Lagged Dependent	P_t	ΔP_t	$\bar{R}^2$	DW	ρ	SEE
3.5.9.1	OLSQ	-135.77 (0.11)	-0.0136(a) (0.57)	0.127 (3.51)	1.14 (9.97)			0.993	2.81 INC.		1584.5
3.5.9.2	GLS	259.28 (0.30)	-0.0262(a) (1.53)	0.1399 (4.45)	1.204 (14.49)			0.997	2.09 N.A. (2.36)	-0.45 (2.29)	1448.38
3.5.9.3	OLSQ	24028.3 (1.63)	-0.00832(a) (0.312)	0.1446 (4.03)	1.06 (7.37)	-232.6 (1.59)	-125.13 (0.85)	0.995	2.68 INC.		1402.0
3.5.9.4	GLS	20598.7 (1.67)	-0.02106 (1.03)	0.157 (5.03)	1.128 (10.01)	-194.53 (1.60)	-133.7 (1.01)	0.997	1.99 N.A.	-0.40 (2.04)	1310.46

Figures in brackets below coefficient estimates are absolute t values.

(a) sign opposite to the expected one.

It was this aspect, if operating, that prompted the choice of the Houthakker-Taylor model to be tried as it allows for positive and negative influences of stocks on expenditure, although the negative but statistically insignificant autocorrelation coefficient, found when equation (3.4.1.18) based on income was estimated, pointed that the stock of physical goods and not that of habits was probably operating[41].

But the results in Table 4 may indicate that for such a mixed and highly aggregated category of goods there is probably not enough information in the available data for a more sophisticated model to be of use in tracing out the influence of these factors.

This kind of modelling many times assumes the existence of an equilibrium level of stocks or expenditure for particular categories of goods at disaggregated or aggretate level. This assumption possibly is more justified for mature industrialised economies already having attained a high degree of development and where great numbers of the population enjoy high standards of living.

But for countries, which have not reached that level of development, with low standards of living for the majority of the population and having experienced rapid growth rates this may not be the case.

Greece during these years went through a period of a lot of changes. Large numbers of people emigrated while even larger numbers moved to urban areas seeking jobs and came into contact with higher living standards and new styles of life already developing there, under the dual but interdependent influence of rising incomes and changing tastes. New goods were for the first time enjoyed by larger numbers of people and the composition of consumption changed significantly while gross national product was growing at a rate between 5-6% per year as Tables 3.1, 3.2, 3.3 and 3.5 show.

The combined influence of these changes, it could be argued, have contributed into inflating expectations about consumption levels, rendering the postulate of an equilibrium level of expenditure probably inoperative. To test tentatively if the equilibrium or desired level of durables expenditure is operating the simple form of the partial adjustment model was estimated.

It was assumed that consumers adjust their expenditure for durables partially each year, according to the identity:

3.5.10 $CD_t - CD_{t-1} = b\ [CD^*_t - CD_{t-1}]$ where $0 \leq b \leq 1$ is the adjustment coefficient.

CD is expenditure on durables and CD^*_t its equilibrium level.

Furthermore the equilibrium expenditure is assumed to be a function of income (Y_t).

3.5.11 $C^*_t - a_o + a_1 Y_t + u_t$

substituting (5.11) into (5.10) and rearranging terms we obtain the equation

3.5.12 $C_t = a_o b + a_1 b Y_t + (1-b)\ C_{t-1} + u_t$

The assumption of a first order autocorrelation for the error term led to a non-linear equation of the form:

3.5.13 $$C_t = a_o b\ (1-\rho) + a_1 bY_t - a_1 b\rho Y_{t-1} + (1-b+\rho)C_{t-1} - (1-b)\rho\, C_{t-2} + \varepsilon_t$$

where ε_t is a random error and ρ the autocorrelation coefficient ($u_t = \rho u_{t-1} + \varepsilon_t$).

The equation (3.5.13) was estimated by non-linear least squares and b, the partial adjustment coefficient has the value of 0.0595, while the value of the t test was only 0.56 (5 percent level of significance), a result which cannot support the hypothesis that in this case, the equilibrium level of expenditure is operating, as the adjustment coefficient is not only very small in magnitude, but also not statistically different from zero.

FOOTNOTES TO CHAPTER 3

1. The figures for these items are taken from the international transactions tables and not from the consumption expenditure tables which give slightly smaller numbers.

2. Because of the limitations of the national accounts in providing the necessary information, the data concerning the three consumption categories are not very accurate for the period 1954-1957, and consequently not strictly comparable with the corresponding figures for the following years 1958-1977.

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12. L. Phlips, Applied Consumption Analysis, 1974.

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15. Houthakker and Taylor, op. cit; P. Taubman, "Permanent and Transitory Income Effects", Review of Economics and Statistics (1969).

16. Mayer, op. cit.

17. Mayer, op. cit., p. 47.

18. Byung-Nak Song, "Empirical Research on Consumption Behaviour", Economic Development and Cultural Change, 29/3 (1981).

19. A. Zellner, D.S. Huang and L.C. Chau, "Further Analysis of the Short-Run Consumption Function with Emphasis on the Role of Liquid Assets", Econometrica, 33/3 (1965).

20. Mayer, op. cit; P. Arestis and G. Hadjimatheou, "The Determinants of the Average Propensity to Consume in the U.K.", Applied Economics, 14 (1982).

21. Zellner et al., op. cit.

22. L.M. Koyck, Distributed Lags and Investment Analysis, 1954; for a criticism of this approach, see Phlips, op. cit., and Z. Griliches, "Distributed Lags: a Survey", Econometrica, 35/1 (1967).

23. Zellner et al., op. cit.

24. In all the estimated equations DY although conceptually similar differs from the figures given in the national accounts. Because in the whole model no equations were estimated for corporation savings, government income from property, interest on public debt and income transfers to government (net) DY has not been adjusted as in the national accounts for these items.

25. Mean lag is calculated from $\sum_{i=o}^{\infty} i\lambda^{i} / \sum_{i=o}^{\infty} \lambda^{i} = \lambda/(1-\lambda)$ for the geometric lag model.

26. J. Johnston, Econometric Methods, 2nd ed., 1972.

27. Johnston, op. cit.; T. Kloek and L.B.M. Mennes, "Simultaneous Equations: Estimation Based on Principal Components of Pre-determined Variables", Econometrica, 28/1 (1960). Analysis of the procedure of TSLS with principal components employed in this work is given above (Chapter 2), where the econometric background is explained, and below (Chapter 9), where the reduced form results are presented.

28. Johnston, op. cit., p. 318.

29. R. Pindyck and D. Rubinfeld, Econometric Models and Economic Forecasts, 1976.

30. Median lag is calculated as T median = log (0.5)/log (λ), in E. Kuh and R.L. Schmalensee, An Introduction to Applied Macroeconomics, 1973.

31. Byung-Nak Song, op. cit.

32. Ferber, op. cit.

33. J.E.H. Davidson, D.F. Hendry, F. Srba and S. Yeo, "Econometric Modelling of the Aggregate Time Series Relationship Between Consumers' Expenditure and Income in the U.K.", The Economic Journal, 88 (1978), p. 674.

34. T. von Ungern-Stenberg, "Inflation and Savings: International Evidence of Inflation Induced Income Losses", The Economic Journal, 91 (1981).

35. A different approach was also tried by using Almon's procedure. Rather arbitrarily a five period polynomial (quite long for prices in yearly data) of second degree without end restrictions was estimated. The results were also disappointing. All the five price terms have the wrong positive signs and were insignificant but for lagged one year prices.

36. In another specification for durables in addition to income and relative prices, investment in housing lagged one period first and then lagged two periods entered the equation under the assumption that housing investment induces expenditure on durables. But in the results housing investment has a negative sign and was statistically insignificant.

37. Johnston, op. cit.

38. J. Winder, "A Note on the Houthakker-Taylor Demand Analysis", Journal of Political Economy, 79 (1971).

39. Clothing expenditure between 1958-1977 comprises 77% of expenditure classified as semi-durables.

40. R. Weisskoff has argued that stock adjustment and habit persistence appear to operate opposite in developing countries (positive for stock and negative for habits). In Studies in Development Planning, H.B. Chenery, ed., 1971.

41. Ferber, op. cit.

4. THE EFFECTS OF WEALTH ON CONSUMPTION EXPENDITURE

4.1 The effects of wealth and particularly of liquid assets on consumption expenditure

As has been discussed earlier in the theories of consumption, wealth forms the basis of permanent income and life cycle hypothesis and according to them provides the stream of income flows. It has been argued that in apart from income people are influenced in their expenditure plans by the total amount of their resources, and many studies have included wealth as a separate variable in consumption functions.

But the main focus is not on total wealth but on specific components of it which considered of particular importance in determining consumers expenditure. The component of wealth which most extensively has been used in consumption functions is liquid assets. While they have been considered as having a considerable and independent effect on different types of expenditure, many times they have been also used as proxy for total wealth.

People may think that liquid assets are the most important part of their wealth when planning to finance their expenditure, because they can incur losses when other forms of wealth are used.

In apart to that it is argued, people may also want liquid assets for transactions and precautionary reasons. They may want them to finance some expenditures occuring at infrequent intervals as it may be the case for some kind of non-durable goods and services.

Or in the case of durables it is necessary for buyers to accumulate savings up to a certain level in order to be able to pay for them.

Another cause for the demand of liquid assets is uncertainty. If people feel insecure about their jobs and incomes they may, for precautionary purposes, try to increase the amount of liquid assets held and reduce borrowing.

It is also argued that people have a desired level of real balances or a desired ratio of liquid assets to incomes. As the motives mentioned above force people to increase the liquid assets they hold, the result may finally be an imbalance between desired and actual level of liquid assets or between them and income. This imbalance, in its turn, may exert an influence on consumption expenditure as people will try to correct it.

To test these hypotheses a number of empirical studies have been conducted employing different models which use as one of the explanatory variables liquid assets expressed in real or current terms.

In this work a liquid assets variable in different forms has been included in the consumption functions for the three categories in order to examine their impact. In addition two particular models were employed. The first is a model which examines the impact of wealth in consumption. As it is extremely difficult, even in well developed countries, to have trustworthy and accurate time series of households wealth, the model for aggregate consumption developed by Stone(1) was used in a slightly modified form. In this model wealth is represented by accumulated real savings.

The second is a model developed by Zellner, Huang and Chau (1965) in which consumption expenditure is influenced not only by income but by positive and negative imbalances in liquid assets.

4.2 Testing the model of wealth

As it is mentioned above, this model relates linearly total consumption expenditure to permanent and transitory income and real wealth. It will be applied to the three consumption functions for non-durables, durables and services and thus requires a slight modification.

The model formally is represented as follows:

4.2.1 $C_{it} = a_1W_t + a_2Y_t^P + a_3Y_t^T + u_t$ $\quad i = 1, 2,3$ stands for the three consumption categories CND, CD, CS and u_t is the error term distributed as $N(0,\sigma^2)$. W_t stands for wealth and Y_t^P, Y_t^T are the permanent and transitory components of income (Y) defined as

4.2.2 $Y_t^P = \lambda \sum_{i=0}^{\infty} (1-\lambda)^i Y_{t-i}$ $\quad Y_t^P$ being a weighted average of current and past incomes with geometrically declining weights and parameter λ being $0 < \lambda \leq 1$

4.2.3 $Y_t^T = Y_t - Y_t^P$ $\quad$ Identity for transitory income.

Total wealth is:

4.2.4 $W_t = W_{t-1} + [Y - TC]_{t-1}$

where TC, total domestic consumption, is the sum of expenditure on non-durables, durables and services.

4.2.5 $$TC_t = CND_t + CD_t + CS_t$$

Wealth is approximated by accumulated past savings except for an arbitrary constant representing wealth in the first period which is to be estimated with the constant term of the equation. Assuming that C_i stands for consumption of non-durables (CND) and substituting equations (4.2.2) and (4.2.3) into (4.2.1) we get:

4.2.6 $$CND_t = a_1 W_t + (a_2 - a_3)\,[\lambda \sum_{i=0}^{\infty} (1 - \lambda)^i Y_{t-i}] + a_3 Y_t + u_t$$

Applying the Koyck transformation and with the use of the identity $\Delta Y_t = Y_t - Y_{t-1}$ we derive the equation:

4.2.7 $$CND_t = a_1 W_t - a_1 (1 - \lambda) W_{t-1} + a_2 \lambda Y_t + a_3 (1 - \lambda) \Delta Y_t + (1 - \lambda) TC_{t-1} + v_t,$$

Where $v_t = u_t - \lambda u_{t-1}$

From the identity (4.2.4) we have that $W_{t-1} = W_t - (Y_t - TC)_{-1}$ substituting for W_{t-1} in (4.2.7) and using identity (4.2.5) as well, the equation (4.2.8) is derived.

4.2.8 $$CND_t = a_1 \lambda W_t + [a_2 \lambda + a_1 (1 - \lambda)]\, Y_t + (a_3 - a_1)(1 - \lambda) \Delta Y_t - a_1 (1 - \lambda)[\, CD + CS\,]_{t-1} + (1-a_1)(1-\lambda)\, CND_{t-1} + v_t$$

Adding in (4.2.8) a constant term $\bar{W}$, to represent wealth in the first period, we finally derive the equation to be estimated

$$4.2.9 \qquad CND_t = a_1\lambda\bar{W} + a_1\lambda W_t + [a_2\lambda + a_1(1-\lambda)]\, Y_t + (a_3-a_1)(1-\lambda)\Delta Y_t - a_1(1-\lambda)\,[CD + CS]_{t-1} + (1-a_1)(1-\lambda)\, CND_{t-1} + v_t$$

In the same way derived, the equations for durables and services are:

$$4.2.10 \qquad CD_t = a_1\lambda\bar{W} + a_1\lambda W_t + [a_2\lambda + a_1(1-\lambda)]\, Y_t + (a_3-a_1)(1-\lambda)\Delta Y_t - a_1(1-\lambda)\,[CND + CS]_{t-1} + (1-a_1)(1-\lambda)CD_{t-1} + v_t$$

$$4.2.11 \qquad CS_t = a_1\lambda\bar{W} + a_1\lambda W_t + [a_2\lambda + a_1(1-\lambda)]\, Y_t + (a_3-a_1)(1-\lambda)\Delta Y_t - a_1(1-\lambda)\,[CND + CD]_{t-1} + (1-a_1)(1-\lambda)\, CS_{t-1} + v_t$$

In all three equations (4.2.9) to (4.2.11) the sum of consumption categories entering as explanatory variables has on a priori grounds a negative sign, the result of the algebraic manipulation of the equations of these model. All equations are overidentified as there are more terms in the equations than parameters to be estimated, and as a result, for some of them more than one estimate can be derived and generally will not be the same. So appropriate restrictions are required leading to non-linear estimation.

First the equations were estimated in unrestricted form by ordinary least squares and as the results, as can be seen in the following Table 1, were unsatisfactory, non linear estimation was attempted, but the results were equally disappointing (Table 2). Equations (4.2.9) to (4.2.11) were estimated under the strong assumption that the error term (v_t) is not autocorrelated. The income variable is represented by Disposable income and savings are derived by subtracting National Consumption expenditure from disposable income and then summed up to construct the wealth variable. Both income and wealth are expressed in real terms having been deflated by consumer price index.

Both equations for durables and services are rejected as they have coefficients with signs opposite to those which are expected from the model (a_1, a_2, a_3 >o and $o < \lambda \leq 1$. Thus the coefficients of W_t and Y_t which are respectively $a_1 \lambda$ and $[a_2\lambda + a_1(1-\lambda)]$ should have positive signs).

The coefficient of disposable income is negative in both equations and in addition the wealth variable in the consumption function for services has the wrong sign as well.

In both, the coefficient measuring the accumulated effect of the other two consumption categories on the estimated one, that is $[TC - \text{dependent variable}]_{t-1}$ has a positive sign while a negative is expected on a priori grounds, as the derived equations (4.2.9) to (4.2.11) indicate. The consumption function for non-durables could have been accepted as it appears that its coefficients seem plausible and have the expected signs. But a close examination reveals that this function as well has a similar defect.

Taking the coefficient of the lagged dependent variable and its estimate in the equation (4.2.9)

$$(1 - a_1)(1-\lambda) = 0.886$$

TABLE 1 OLS ESTIMATES FOR THE THREE CONSUMPTION FUNCTIONS

No. Equation	Dependent Variable	Coefficients of Constant	W	Y	ΔY	Lagged TC - Dependent Variable	Lagged Dependent Variable	$\bar{R}^2$	DW	SEE
4.2.9	CND	8298.3 (2.18)	0.02139 (2.42)	0.104 (3.42)	0.0396 (1.33)	-0.285 (2.73)	0.886 (8.49)	0.998	1.81 N.A.	986.49
4.2.10	CD	-3182.28 (0.60)	0.02534 (1.92)	-0.061 (1.42)	0.151 (3.67)	0.15 (1.38)	0.616 (2.92)	0.995	2.41 INC.	1356.97
4.2.11	CS	-5131.1 (1.97)	-0.00852 (1.38)	-0.0106 (0.45)	0.09893 (4.52)	0.243 (3.21)	0.68 (3.97)	0.998	2.24 INC.	719.6

Figures in brackets below the coefficients are absolute t values.

Rearranging we get $(1 - \lambda) - a_1(1 - \lambda) = 0.886$ and $(1 - \lambda) = 0.886 + a_1(1 - \lambda)$

But $a_1(1 - \lambda)$ is the coefficient of the variable $[TC - CCD = CS)]_{t-1}$ which value is 0.285.

Inserting this value for $a_1(1 - \lambda)$ results in $(1 - \lambda) = 1.171$.

This result implies a negative value for λ, the weight parameter in the distributed lag for permanent income, which by assumption is positive and less than one.

It should be noted, as shown in Table 2, that the non-linear estimation for non-durables produced a negative value for λ.

TABLE 2. RESULTS OF NON-LINEAR ESTIMATION OF THE WEALTH MODEL FOR CONSUMPTION

Parameters	CND	CD	CS
Constant	-252490.0 (0.0618)	-3607.22 (2.14)	-3224.4 (2.97)
a_1 (Wealth)	0.0901 (1.77)	0.4919 (15.86)	-0.6457 (1.05)
a_2 (Permanent Income)	1.78 (0.0846)	0.342 (89.41)	0.3397 (2.95)
a_3 (Transitory Income)	1.849 (0.087)	0.285 (14.84)	0.593 (3.51)
λ (of Distributed Lag)	-0.0107 (0.0668)	4.40 (6.14)	0.667 (3.12)
DW	1.58 INC.	1.22 INC.	2.06 N.A.
SEE	1115.6	1921.9	720.15

(Absolute t values in brackets at 5% level of significance.)

The results of non-linear estimation were disappointing. The wealth coefficient being negative for services, extremely large magnitudes in the coefficients of permanent and transitory income for non-durables, and in addition a negative λ. In durables the estimation produce a value 4.40 for λ which by assumption should not exceed one.

4.3 Imbalance in liquid assets

Zellner et al. (1965) have tested a structural model for total consumption of the permanent income type where in addition to it expenditure is influenced by the imbalance between desired and actual held liquid assets. They used the same set of equations (4.1.1), (4.1.2) and (4.1.6) but in the first of them they added a term to account for the imbalance effect, so that the form of the equation is:

4.3.1 $$C_t = a_o + a_1 Y_t^e + a_2 (LA_{t-1} - LA_t^d) + u_t$$

4.3.2 $$Y_t^e - Y_{t-1}^e = (1 - \lambda) [Y_t - Y_{t-1}^e]$$ which implies that

4.3.3 $$Y_t^e = (1 - \lambda) \sum_{i=0}^{\infty} \lambda^i Y_{t-i} \qquad \text{and } 0 < \lambda \leq 1$$

Where as before C_t stands for real total consumption, Y_t^e is the expected real disposable income, LA_{t-1} actual real liquid assets held at the end of previous period and LA_t^d the desired level of real liquid assets at the current period.

They further assumed that the desired level of liquid assets is proportional to expected income as

4.3.4 $$LA_t^d = bY_t^e$$

Substituting successively (4.3.4) and (4.3.3) into (4.3.1) and applying the transformation suggested by Koyck the consumption function to be estimated is derived as:

4.3.5 $$C_t = a_o\ (1-\lambda) + (a_1 - a_2 b)(1-\lambda)Y_t + a_2 LA_{t-1} - a_2 \lambda LA_{t-2} + \lambda C t-1 + v_t$$

and $v_t = u_t - \lambda u_{t-1}$

Equation (4.3.5) is overidentified with respect to coefficient a_2 which is subject to non-linear restriction that the coefficient of LA_{t-1} times that of C_{t-1} equals minus the coefficient of LA_{t-2}. It should also be stressed that a_1 and b cannot be identified from the estimated coefficient of imcome Y_t. This equation was estimated in the unrestricted form with ordinary least squares assuming that the error term is not autocorrelated.

For all three consumption categories the equation (4.3.5) was estimated using real disposable income for Y_t. The variable liquid assets is the sum of currency in circulation (including sights deposits) plus time, demand and savings deposits deflated by consumer price index.

The results follow below with the t test absolute values in brackets below the coefficients at 5% level of significance.

4.3.6 $$CND_t = \underset{(0.24)}{870.34} + \underset{(8.03)}{0.185DY_t} + \underset{(9.48)}{0.73CND_{t-1}} - \underset{(4.06)}{0.169LA_{t-1}} + \underset{(1.50)}{0.047LA_{t-2}}$$

$\bar{R}^2 = 0.998$ DW = 1.75 N.A.   SEE = 945.2

4.3.7 $$CD_t = \underset{(2.04)}{-9529.09} + \underset{(2.29)}{01074DY_t} + \underset{(5.73)}{1.19CD_{t-1}} - \underset{(1.32)}{0.143LA_{t-1}} - \underset{(0.44)}{0.0249LA_{t-2}}$$

$\bar{R}^2 = 0.99$ DW = 2.47 INC.   SEE = 1964.1

4.3.8 $$CS_t = \underset{(4.86)}{13603.0} + \underset{(5.46)}{0.0819} + \underset{(11.4)}{1.35CS_{t-1}} - \underset{(3.40)}{0.119LA_{t-1}} - \underset{(3.52)}{0.0824LA_{t-2}}$$

$\bar{R}^2 = 0.999$ DW = 2.11 N.A.   SEE = 670.6

In the three equations (4.3.6) to (4.3.8) the signs of the coefficient for LA_{t-1} and LA_{t-2} failed to satisfy the a priori expectations that is positive for the former variable and negative for the latter as equation (4.3.5) shows.

In the equation for non-durables they have swapped signs while in those for durables and services only the variable LA_{t-1} has the wrong sign. In addition to that, in the last two equations the coefficient of lagged dependent variable (λ) has a value exceeding one, contrary to the assumption in (4.3.3) (a distributed lag to form expected income with weights (λ) declining geometrically).

4.4 The results of equations with liquid assets

As it has been mentioned earlier, economic theory has convincingly argued that liquid assets exercise an independent and positive influence on consumption expenditures and many empirical tests have supported that.

So, despite the fact that the particular model for real balance effects, estimated in the previous section, failed to establish the link between them, a number of attempts were made to identify the relation (if any) between liquid assets and consumption.

Liquid assets entered the consumption functions either in the form of the ratio between them and disposable income or at levels.

The first form was based on the view that there is a desired ratio of assets to income and deviations from this ratio will induce consumers to adjust accordingly their expenditure so to restore the ratio to the desired level.

For the second form (the level of liquid assets) it has been argued that liquid assets are the most important component of wealth and exercise an independent influence on consumption expenditure.

In addition, the first differences in liquid assets and in the ratio between them and disposable income were also used in the estimated equations because change, as represented by this form, could probably have more influence on some types of expenditure at least.

The variables representing liquid assets were linearly included in the equation (3.4.1.7) and it was assumed that they adequately approximate the relation between them and consumption expenditure[2]. Based on the equation $C_t = a_o(1-\lambda) + a_1(1-\lambda)Y_t + \lambda C_{t-1} + v_t$ (3.4.3.7) the following forms were estimated for non-durables, durables and services expenditure:

4.4.1 $$C_t = a_o(1-\lambda) + a_1(1-\lambda)DY_t + \lambda C_{t-1} + a_2 \frac{LA}{DY}t + v_t$$

4.4.2 $$C_t = a_o(1-\lambda) + a_1(1-\lambda)DY_t + \lambda C_{t-1} + a_2 LA_t + v_t$$

4.4.3 $$C_t = a_o(1-\lambda) + a_1(1-\lambda)DY_t + \lambda C_{t-1} + a_2[LA_t - LA_{t-1}] + v_t$$

There were also added two equations to provide for the case of a lag reaction to the level and change of liquid assets as:

4.4.4 $$C_t = a_o(1-\lambda) + a_1(1-\lambda)DY + \lambda C_{t-1} + a_2 LA_{t-1} + v_t$$

4.4.5 $$C_t = a_o(1-\lambda) + a_1(1-\lambda)DY + \lambda C_{t-1} + a_2 [LA_t - LA_{t-1}]_{-1} + v_t$$

and $v_t = u_t - \lambda u_{t-1}$ for all the above equations.

The equations (4.4.1) to (4.4.5) were estimated by ordinary least squares under the assumption that the error term is not autocorrelated.

If the outcome was encouraging, particularly if the coefficients had the expected positive signs, the equation was re-estimated by generalised least squares, using the procedure mentioned earlier, to remove autocorrelation because of the severe consequences it has on the estimates. A first order scheme was assumed adequate and non-linear estimation was not attempted as the previous estimations (Ch. 3, Table 1) showed that the procedure applied gave satisfactory results. To account for simultaneity error as consumption expenditures, liquid assets and incomes are part of a larger model the procedure for TSLS mentioned in a previous section was also used.

TABLE 3 RESULTS FOR CONSUMPTION FUNCTIONS WITH REAL LIQUID ASSETS OVER REAL DISPOSABLE

No. Equation	Statistical Procedure	Dependent Variable	Coefficients of				DW	ρ	$\bar{R}^2$	SEE
			Constant	Disposable DY	Lagged Dependent	LA/DY				
4.4.6	OLSQ	CND	10890.4 (5.21)	0.1139 (4.86)	0.6338 (8.48)	2387.68 (0.417)	1.64 N.A.		0.997	1291.15
4.4.7	GLS	CND	14401.7 (5.80)	0.155 (7.06)	0.521 (6.48)	-2881.6 (0.29)	1.82 N.A.	0.50 (2.70)	0.992	1252.7
4.4.8	TSLS	CND	11853.6 (4.99)	0.122 (4.53)	0.581 (6.68)	6709.1 (1.08)	1.46 INC.			1326.09
4.4.9	OLS	CD	-1615.39 (1.05)	0.0464 (1.46)	0.882 (7.47)	-2615.22 (0.28)	2.16 N.A.		0.989	2030.4
4.4.10	OLS	CS	909.9 (1.12)	0.0543 (2.37)	0.793 (9.73)	3973.18 (0.81)	1.09 INC.		0.997	1056.13
4.4.11	GLS	CS	-6231.4 (2.03)	0.08149 (5.35)	0.577 (7.50)	29233.9 (3.93)	1.97 N.A.	0.816 (6.64)	0.977	780.13
4.4.12	TSLS	CS	1092.7 (1.29)	0.0645 (2.61)	0.759 (8.82)	2812.13 (0.53)	1.05 INC.			1061.7

In the following Tables 3 and 4 a sample of the results from the estimation of equations (4.4.1) to (4.4.5) is given (figures in brackets below the coefficients are absolute t values at 5% level of significance).

Table 3 presents the results of the equation (4.4.1) where the ratio of real liquid assets to real disposable income($\frac{LA}{DY}$)was included.

In the consumption for non-durables (eq. 4.4.6) the coefficient of $\frac{LA}{DY}$ has the positive sign (suggested by economic theory as mentioned above) but it is statistically insignificant and its magnitude less than its standard error. As the equation is suspected for autocorrelation it was re-estimated by GLS and the outcome (eq. 4.4.7) was an unexpected negative coefficient for $\frac{LA}{DY}$ with a t value lower than that from OLS estimation showing the latter to be of spurious nature. In addition it has a slightly lower $\bar{R}^2$ and a statistically significant autocorrelation coefficient $\rho = 0.50$. The TSLS estimates (eq. 4.4.8), ranging between those of the other two estimation methods, have improved the qualities of the $\frac{LA}{DY}$ parameter but this equation has a very low DW statistic (in the inconclusive range) and worse standard error of estimate. The results for durables (eq.4.4.9) are equally disappointing as the coefficient of $\frac{LA}{DY}$ has a negativesign and itisstatistically insignificant (t value 0.28); and hence no other estimation procedures were tried. The results for services expenditure were somehow better. The coefficient of $\frac{LA}{DY}$ had the expected positive sign but it was statistically insignificant. Furthermore the DW statistic from the OLS estimation (eq. 4.4.10) was in the inconclusive range. When the equation was re-estimated for first order autocorrelation by GLS (eq. 4.4.11) the results showed a marked improvement. The magnitude of income coefficient has increased and simultaneously its standard error decreased so that its t value was more than doubled in comparison with its t value in equation(4.4.10). More interestingly the coefficient of $\frac{LA}{DY}$ not only retained its expected positive sign but now it was statistically significant (t value 3.93). It should be noted that the $\bar{R}^2$ in equation (4.4.11) is lower (0.977) than the corresponding OLS estimate 0.99 (eq. 4.4.10), which could be explained on the grounds that the inclusion of the variable $\frac{LA}{DY}$ because of the uniform trend exhibited in the data increased the already existing autocorrelation in the residuals so in equation (4.4.10) the relevant coefficient ρ being as high as 0.816.

On the other hand the negative aspect of equation (4.4.11) is its forecasting performance outside the sample period as the value of the statistic $Z_1(k)$ shows ($Z_1(2)$ = 10.742 in excess of the critical value of 5.992). The $Z_1(k)$ statistic is used in this work tentatively as an indication of the constancy of the parameters outside the sample period; because of data limitation as the model is a yearly one, the degrees of freedom k for this statistic are confined to only two, and as it has been repeatedly stressed $Z_1(k)$ is biased in rejecting the null hypothesis in small samples.

Turning into the discussion of the results from the estimation of equations (4.4.2) to (4.4.5), where liquid assets or its first differences were included, a sample for each consumption category is presented in the following Table 4.

TABLE 4 RESULTS OF ESTIMATED FUNCTIONS INCLUDING LIQUID ASSETS

No. Equation	Estimated Procedure	Dependent Variable	Coefficient Of: Constant	DY Disposable	Lagged Dependent V	LA	LA_{t-1}	Δ LA	ΔLA_{t-1}	DW	ρ	$\bar{R}^2$	SEE
4.4.13	OLSQ	CND	5897.08 (1.58)	0.1526 (5.67)	0.688 (8.91)	-0.0627 (1.61)				1.77N.A.		0.998	1217.06
4.4.14	OLSQ	CND	1042.6 (0.312)	0.1605 (7.51)	0.7688 (10.92)		-0.108 (3.42)			1.78N.A.		0.988	1019.06
4.4.15	GLS	CND	13443.3 (5.64)	0.1435 (6.45)	0.541 (7.32)			0.0343 (1.02)		1.82N.A.	0.45 (2.36)	0.993	1220.2
4.4.16	TSLS	CND	11291.3 (4.76)	0.118 (4.50)	0.6227 (7.12)			0.0707 (1.87)		1.34INC			1309.1
4.4.17	OLSQ	CND	12706.4 (5.39)	0.1401 (5.28)	0.568 (6.57)				-0.058 (1.44)	1.26INC		0.997	1261.17
4.4.18	OLSQ	CD	7582.11 (2.30)	-0.06708 (1.67)	0.656 (5.39)	0.191 (3.04)				2.58INC		0.993	1667.10
4.4.19	OLSQ	CD	-7094.2 (1.73)	0.0891 (2.14)	1.1067 (5.81)		-0.121 (1.38)			2.33INC		0.990	1938.87
4.4.20	GLS	CD	-401.037 (0.50)	0.00116 (0.08)	1.055 (15.64)			0.1407 (4.38)		2.30N.A. (2.65)	-0.492 (2.65)	0.997	1475.74
4.4.21	TSLS	CD	-624.30 (0.49)	0.0062 (0.29)	1.0187 (10.05)			0.176 (3.55)		2.75INC			1694.05

TABLE 4 Continued

No. Equation	Estimated Procedure	Dependent Variable	Coefficient Of: Constant	DY Disposable	Lagged Dependent V	LA	LA_{t-1}	Δ LA	ΔLA_{t-1}	DW	ρ	$\bar{R}^2$	SEE
4.4.22	GLS	CD	-956.04 (0.66)	0.0202 (0.82)	0.983 (8.51)				0.0361 (0.62)	2.04N.A.	-0.259 (1.23)	0.992	2085.8
4.4.23	TSLS	CD	-1684.5 (1.01)	0.0349 (1.27)	0.918 (7.09)				0.00891 (0.14)	2.29N.A.			2075.9
4.4.24	GLS	CS	9320.53 (4.83)	0.016 (0.89)	0.569 (8.25)	0.1209 (4.61)				1.92N.A.	0.424 (2.20)	0.997	667.45
4.4.25	TSLS	CS	12323.6 (5.15)	-0.00445 (0.20)	0.502 (6.44)	0.166 (4.66)				1.20INC			765.9
4.4.26	OLSQ	CS	-6195.2 (1.94)	0.0875 (4.71)	1.03 (8.08)		-0.107 (2.39)			1.24INC		0.998	941.5
4.4.27	OLSQ	CS	931.96 (2.48)	0.0402 (3.53)	0.86 (18.05)			0.103 (6.22)		1.71N.A.		0.999	615.56
4.4.28	TSLS	CS	889.7 (2.30)	0.04007 (3.23)	0.862 (16.70)			0.113 (5.93)		1.81N.A.			623.4
4.4.29	GLS	CS	948.9 (0.91)	0.0685 (2.96)	0.767 (8.13)				0.1228 (0.39)	1.61N.A.	0.40 (2.04)	0.994	1010.13

Figures in brackets below coefficients are absolute t values at 5% level of significance.

In the consumption function for non-durables the liquid assets (LA) variable, whether it was included in the equation at current or lagged period, had a negative sign contrary to the expected one. When instead, their first differences were included its coefficient had the correct positive sign, but it was statistically insignificant; no important change to its magnitude and standard error took place when the generalised least squares (GLS) procedure was applied (equation 4.4.15, in Table 4). The TSLS estimates for the same function (equation 4.4.16) improved the statistical significance of the coefficient for LA (the t value being 1.87), but the Durbin-Watson statistic was in the inconclusive range (1.34), so that not much faith could be placed on these figures.

The results with the lagged first differences of liquid assets (ΔLA_{t-1}) were equally disappointing as their coefficient was negative and insignificant (equation 4.4.17). When the level of liquid assets was included in the durables equation (4.4.18) it resulted in changing to negative the sign of the income coefficient.

The lagged value of them (LA_{t-1}), when included, restored the sign on the income coefficient, but its own sign became negative and statistically insignificant.

While the inclusion of the lagged first differences of liquid assets had almost no influence (equation 4.4.23), the current periods first differences (ΔLA_t) invalidated completely the relation between durables expenditure and income.

The income coefficient was statistically almost zero (t value 0.08) and the coefficient of lagged dependent variable exceeded one (equation 4.4.20) implying a negative value for λ, the parameter in the distributed lag of income determination (equation 4.3.3) contrary to the assumption that it is less than one ($0<\lambda<1$).

The results for the consumption function of services (equations 4.4.24 to 4.4.29 in Table 4) follow almost the same pattern with those of durables.

The impact of including liquid assets was to make the income-consumption (for services) relation unstable. In whatever form liquid assets were included, their coefficient had the expected positive sign (except when their lagged values were used, equation 4.4.26) and was statistically significant (except for the lagged first differences, (equation 4.4.28). In some cases its magnitude was more than six times its standard error (equation 4.4.27).

At the same time, the inclusion of liquid assets in the services function lowered considerably the magnitude of the income coefficient as compared with equation (3.4.1.19) from which they were excluded. Generalised and TSLS estimates did not present any important improvement (Table 4).

In some cases the income coefficient decreased to such a low magnitude as 0.016 (t value 0.89). In other cases the coefficient of lagged dependent variable increased in magnitude so that the implied mean lag was doubled to six years (equation 4.4.27) as compared with the mean lag of 3 years of equation (3.4.1.19) in which only income was included, and this increase does not seem plausible. It implies a smaller influence out of current income on the type of expenditures included in the services category. The opposite (higher dependence on current income) could be expected at least for a country with not very high incomes. In addition most of the evidence[3] for the consumption lag comes in favour rather of the shorter than the longer lag, at least for the aggregate consumption[4].

Finally equation (4.4.27) was projected outside the sample period for the next two years 1978 and 1979; its forecasts were outperformed by the simpler form of equation (3.4.1.19) without liquid assets.

The sum of the forecast error of the equation (4.4.27) was 4.1 billion drs compared with 2.9 billion drs of equation (3.4.1.19) an increase of about 40%. The test statistic $Z_1(2)$ for the parameters constancy was also calculated and its value 34.685 was well in excess of the critical value 5.992 ($\chi^2_{(2)}$ distribution). As it has been mentioned the value for the same statistic of equation (3.4.1.19) is 5.763 only.

4.5 Further attempts with liquid assets

In a different sometimes context[5], nominal liquid assets have been included in consumption functions. They are considered as the variable that exercises an influence on consumption expenditures.

The inclusion of nominal liquid assets in the three consumption categories produced mixed results. A representative sample of these results is presented in the following Table 5.

In the consumption for non-durables the coefficient of nominal liquid assets was always statistically insignificant and less than its standard error, while its sign was mostly negative, regardless of the form used for them (level, first differences, etc.).

TABLE 5. RESULTS WHEN NOMINAL LIQUID ASSETS INCLUDED IN CONSUMPTION FUNCTION

No. of Equation	Estimated Procedure	Dependent Variable	Coefficient Of: Constant	Disposable Income	Lagged Dependent	LA Value	LAV_{t-1}	Δ LAV	Δ LAV_{t-1}	DW	ρ	$\bar{R}^2$	SEE
4.5.1	OLSQ	CND	8828.99 (12.50)	0.1136 (4.80)	0.684 (6.55)	0.074 (0.89)				1.58INC		0.997	1300.4
4.5.2	OLSQ	CND	10285.1 (3.30)	0.114 (4.88)	0.654 (7.00)		-0.00215 (0.315)			1.62N.A.		0.997	1293.6
4.5.3	GLS	CD	-1919.45 (3.74)	0.119 (8.86)	0.225 (2.42)			0.193 (8.99)		2.06N.A.	-0.40 (2.04)	0.998	841.9
4.5.4	GLS	CD	-1645.25 (1.75)	0.1048 (4.75)	0.329 (2.15)*				0.2167 (4.57)	2.13N.A.	-0.232 (1.09)	0.996	1412.58
4.5.5	TSLS	Cd	-1918.41 (1.78)	0.1077 (4.59)	0.3227 (1.95)*				0.2101 (4.11)	2.34N.A.			1410.08
4.5.6	GLS	CS	4228.37 (2.74)	0.0938 (4.93)	0.568 (5.49)	0.0134 (2.48)				1.81N.A.	0.40 (2.04)	0.996	851.36
4.5.7	OLSQ	CS	4135.5 (4.26)	0.1047 (5.66)	0.535 (5.71)			0.0594 (3.44)		1.22INC		0.998	846.3
4.5.8	GLS	CS	13236.3 (2.02)	0.0694 (4.84)	0.534 (6.46)			0.103 (4.54)		2.08N.A.	0.934 (12.2)	0.930	756.7
4.5.9	GLS	CS	2787.24 (2.07)	0.0843 (4.26)	0.653 (6.75)				0.0462 (1.78)*	1.75N.A.	0.365 (1.74)	0.995	933.7

Figures in brackets below estimates are aboslute t values at 5% level of significance. Those starred * are significant in 5% level and in one tail test.

When the level of nominal liquid asset was included in the durables consumption function (whether the current or the lagged period) it changed into negative the sign of the lagged dependent variable making it an unacceptable result. (By assumption $0 \leq \lambda \leq 1$). On the other hand the use of the first differences of nominal liquid assets (current or lagged period) produced coefficients statistically significant and with the expected sign. The magnitude of income coefficient increased, sometimes more than twice compared with the equation without liquid assets (3.4.1.18 without relative prices and 3.4.2.21 with them). Simultaneously the coefficient of lagged dependent variable decreased, was rendered statistically insignificant implying, because of its low magnitude, a mean lag of less than half a year.

This seems implausible for expenditure of the kind of durables, even if it is taken into consideration that most of the expenditure included in this category is classified as semi durables (Table 3.1 in Appendix 1).

A further drawback was their considerably poor performance outside the sample period. The sum of forecasting error for the two years 1978-1979 is 16.4 billion drs for equation (4.5.3) and 20.4 billion drs for equation (4.5.4) compared with 6.2 billion drs for equation (3.4.1.11) without liquid assets. The values of the $Z_1(2)$ statistic were 199.9 and 126.8 respectively well in excess of 7.23 for equation (3.4.1.11).

For the consumption of services the results were very satisfactory. In whatever form the variable for nominal liquid assets was included in the equation its coefficient had always the expected positive sign and was statistically significant; the value of t test ranging from 1.74 to 4.54. Apart from this, the relation between income and expenditure was more stable for services, relatively to the other two consumption categories when nominal liquid assets were included in all.

The coefficients of income and lagged expenditure of services were 0.0734 and 0.0749 respectively (equation 3.4.1.19 without liquid assets). After the inclusion of liquid assets the former ranged between 0.069 and 0.10 and the latter between 0.53 and 0.65 (equations 4.5.6 to 4.5.9). Another point worth mentioning is that, when the first differences in nominal liquid assets were included the correlation in the residuals increased, as compared with equations (3.4.1.19) and (4.5.6). For the last two equations the autocorrelation coefficient was 0.438 and 0.40 respectively while for equation (4.5.8) ρ has the value of 0.934.

When autocorrelation was removed by the GLS procedure the goodness of fit measured by $\bar{R}^2$ for equation (4.5.8) was considerably lowered, being 0.93, compared with the R^2 of equations (3.4.1.19) and (4.5.6), the values being 0.994 for the former and a little higher 0.996 for the latter.

In addition equation (4.5.6) performed better than the equation (4.5.8) when both were extrapolated for the years 1978-1979, and only the former had a value for $Z_1(2)$ statistic smaller than the critical one. This equation (4.5.6), which includes nominal liquid assets, forecasts better than any other of consumption of services including equation (3.4.1.19).

The sum of forecast error for the two years is 1.8 billion drs for equation (4.5.6) and 2.9 for (3.4.1.19) a decrease of 38%.

The $Z_1(k)$ statistic with two degrees of freedom is 2.667 for the former equation and 5.763 for the latter while the critical value is 5.992. As equation (4.5.6) has in addition a high value for the Durbin-Watson statistic (1.81) and a lower standard error of estimate than equation (3.4.1.19) it is considered as the function that best represents the data for consumption of services expenditure. Summing up the examination of the influence of liquid assets on consumption expenditure, we may conclude that no satisfactory relation was possible to be established between them and expenditure on non-durables whether nominal or real liquid assets were used.

For the durables consumption function a different picture emerged. Economic theory suggests that expenditure is influenced by total resources a part of which are liquid assets. It is also suggested that for some forms of expenditure, like durables, a period to accumulate resources is required.

The variable of real liquid assets, very rarely statistically acceptable, almost swapped the income effect, probably because of the high degree of interelatedness existing between them. At the same time the coefficient of the lagged dependent variable implied a very long lag ranging between 8-12 years[6]. Nominal liquid assets reversed these effects.

Almost all influence on durables expenditure is now exercised by current income, past incomes effect becoming negligible, and that implies an implausible mean lag of less than half a year.

Credits to consumer would be a better explanatory variable for durables than liquid assets, but it was not used because data were not available.

Almost the same pattern emerged for the consumption of services. But in this case the relation between income and expenditure was generally more stable than in the case for durables.

The rise in accumulated assets will facilitate expenditure and lead to a shorter lag between consumption and income. This has been reflected in the consumption function of services whether nominal liquid assets or the ratio of real liquid assets to real disposable income was used.

Between them the equation with nominal liquid assets was finally selected because ceteris paribus, it has a higher goodness of fit and forecast better outside the sample period. Moreover the rise in nominal liquid assets, in a growing economy, may influence the expectations of increasing wealth that could permit an expansion of the expenditure for services, which can be reduced easier than expenditure for consumption of durables, because of the latter's usual contractual commitments.

4.6 Effects from inflation, interest rates and unemployment

It has been argued and some evidence has been produced that consumers are subject to money illusion (W. Branson and A. Klevorick 1969) and that the price level or the inflation rate might exercise an independent influence on consumption.

If money illusion exists especially in periods of rapid inflation consumers may increase present consumption at the expense of future one. On the other hand inflation could be distinguished as anticipated and unanticipated as Juster and Wachtel (1972) have shown, concluding that anticipated inflation could increase present consumption and unanticipated may decrease it. A higher degree of economic uncertainty could also lead to this result. These could suggest that the proper variable to be included in consumption function is the expected rate of inflation.

Because of the difficulties to construct a proper index of price expectations, it was decided to use the rate of increase of consumer price index lagged one year as a measure of inflation expectations, under the assumption that consumers will expect the same rate of inflation to prevail in the next period, that is the expected rate of inflation (PE) is $PE = \left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}\right)_{t-1}$ where CPI is the consumer price index.

In the functions regressing consumption on disposable income and the lagged dependent variable, the variable representing the expected rate of inflation (PE_t) was included in a linear form.

The results (Table 6) show that the coefficient for the expected rate of inflation was not only statistically insignificant but less than its standard error indicating that the hypothesis of inflation expectations formed as a simple extrapolation of last periods actual inflation could not be accepted and thus this variable was dropped from the consumption functions.

It should be noted that the coefficient of expected rate of inflation has a negative sign in the consumption of services and a positive one in consumption of non-durables and durables.

The ratio of real savings to real disposable income (Table 3.2; Appendix 1) declined from its peak value around 23.5 in 1973 to a figure around 18% for 1974-1977. Thus, the hypothesis that high inflation rate results in increasing the savings income ratio is not applicable in the case of Greece. From Table 3.3 (Appendix 1) it can be seen that the rate of growth for all consumption categories decreased during 1974-1977 in comparison with growth rates between 1969-1973. But if semi durables are excluded from the durables

TABLE 6. CONSUMPTION FUNCTIONS WITH INFLATION AND INTEREST RATES

No. Equation	Statistical Procedure	Dependent Variable	Coefficient Of					DW	ρ	$\bar{R}^2$	SEE
			Constant	Disposable Income	Lagged Dependent	PE_{t-1}	Discount Rate				
4.6.1	OLSQ	CND	12225.1 (4.66)	0.126 (5.06)	0.597 (6.64)	48.6 (0.79)		1.31 INC.		0.997	1309.12
4.6.2	OLSQ	CD	-2084.09 (1.30)	0.045 (1.67)	0.864 (5.96)	23.28 (0.23)		2.12 N.A.		0.989	2073.1
4.6.3	OLSQ	CS	783.7 (0.91)	0.057 (2.44)	0.821 (7.54)	-41.69 (0.72)		1.24 INC.		0.997	1067.6
4.6.4	OLSQ	CD	-4219.39 (1.73)	0.0571 (1.94)**	0.806 (5.51)		215.2 (0.90)	2.14 N.A.		0.990	1992.3
4.6.5	GLS	CD	-3068.2 (1.11)	0.0425 (1.57)	0.878 (6.46)		151.1 (0.69)	1.95 N.A.	-0.20 (0.95)	0.992	2020.7

Figures in brackets below estimates are absolute t values.

** significant in 5% and in 1 tail test.

category the growth rate of the latter part between 1974-1977 is the highest from all previous periods.

The ratio of real national consumption expenditure to GNP rose from 65.8 in 1973 to 68.5 in 1977 (Table 3.1, Appendix 1). In addition the real expenditure for some durables, like personal transport equipment quadrupled from about 2000 million drs in 1973 to more than 9000 million drs in 1977 and its annual rate of growth from an average 21% between 1969-1973 reached an average rate of 47% for the period 1974-1977 (Table 3.7 in Appendix 1) despite attempts to restrict their imports.

It could be thus tentatively argued that, because of the erosion of incomes due to rapid inflation, consumers were forced to maintain their standard of living drawing from their savings. In addition, the anticipation of higher inflation rates was also another factor leading to increased purchases of some durables considered as real assets so as to protect the real value of their savings(7).

The cost of credits to households is another factor which could affect negatively consumption expenditures and especially those for durables. So the discount rate was used in the durables consumption functions as it was considered a good proxy for changes as household credits. The inclusion of discount rate did not improve the durables consumption function. Its coefficient was statistically insignificant (t value less than one) and had a positive sign contrary to expectations.

The use of unemployment as proxy for expectations concerning economic activity had no significant influence. Only in durables this variable had the correct sign, but being insignificant and as unemployment figures were declining all these years, no further attempts in this direction were made.

Recapitulating the three finally selected functions which adequately generate the data for consumption categories are for:

Consumption of Non-durables

3.4.1.17 $$CND_t = \underset{(6.04)}{14078.3} + \underset{(7.22)}{0.1515}DY_t + \underset{(7.30)}{0.519}CND_{t-1} \qquad \rho = \underset{(2.42)}{0.459}$$

$$\bar{R}^2 = 0.993 \quad DW = 1.82 \text{ N.A.} \quad SEE = 1221.56 \quad Z_1(2) = 12.596$$

Consumption of Durables

3.4.2.21 $$CD_t = \underset{(1.64)}{26968.1} + \underset{(2.45)}{0.0584}DY_t + \underset{(5.49)}{0.743}CD_{t-1} - \underset{(1.76)^{**}}{281.6}\frac{PCD}{CPI}_t$$

$$\bar{R}^2 = 0.991 \quad DW = 191 \text{ N.A.} \quad SEE = 1886.79 \quad Z_1(2) = 3.507$$

** Significant in one tail test.

Consumption of Services

4.5.6 $$CS_t = \underset{(2.74)}{4228.37} + \underset{(4.93)}{0.0938}DY_t + \underset{(5.49)}{0.568}CS_{t-1} + \underset{(2.48)}{0.0134}LAV_t \qquad \rho = \underset{(2.09)}{0.40}$$

$$\bar{R}^2 = 0.996 \quad DW = 1.81 \text{ N.A.} \quad SEE = 851.3 \quad Z_1(2) = 2.667$$

For the three finally selected equations for the consumption categories the root mean square error (RMSE) and the root mean square percent error (RMSPE) were also calculated to test the forecasts generated by these equations for the years 1978 and 1979 for which disaggregated data were available. The values of these statistics as the following table shows are quite small indicating a satisfactory forecasting performance of these equations for the few years outside the sample period, although the forecasting period is short to permit conclusions to be drawn with certainty.

Variables	RMSE In Billion Drs	RMSPE %
CND	3.1	2.12
CD	2.5	3.15
CS	1.0	0.97

FOOTNOTES TO CHAPTER 4

1. A. Deaton, "Personal Consumption", in Economic Structure and Policy, ed. by T.S. Barker, 1976.

2. Instead of equation (3.4.1.7), at first the liquid assets variable was included in the equation (3.4.1.1.)

   $C_t = a_o + a_1 Y_t^e + u_t$, an approach considered more sound than to use directly the equation with the measured instead of the expected income. This approach gave an estimated equation with current and lagged liquid assets, the first with a positive and the second with a negative coefficient. After some experiments, this approach was abandoned as it produced coefficients with wrong signs and statistically insignificant, and in some cases (services) the implied wealth lag seems implausible being longer than 6 years.

3. T. Mayer, Permanent Income, Wealth and Consumption: a Critique of the Permanent Income Theory, the Life Cycle Hypothesis and Related Theories, London 1972.

4. Equation (4.4.27) implies a longer adjustment of expected income to measured income (relation 3.4.1.5). The figures are 0.14, 0.12, 0.10..., and half of this will have been completed between 4 and 5 years. The corresponding figures for equation without liquid assets (3.4.1.19) are 0.25, 0.19, 0.14 and half of the adjustment is completed between 2 and 3 years.

5. P.L. Cheng, "Consumption of Non-durable Goods and Contractual Commitment of Disposable Income", The Review of Economics and Statistics, 45 (1963). M. McCarthy, the Wharton Quarterly Economic Forecasting Model, Mark III, 1972.

6. As it has been mentioned, most of the expenditure included in the durables category is usually classified as semi durables.

7. R. Weisskoff, "Demand Elasticities for a Developing Economy", in Studies in Development Planning, ed. H.B. Chenery, 1971.

5. ESTIMATION OF THE INVESTMENT CATEGORIES FUNCTIONS

5.1 Introduction

Total gross fixed investment is around 20% of the gross national product at market prices in the period 1954-1977, both expressed in real terms (base year 1970). Investment is not only part of the final demand, but more importantly contributes to the increase of the productive capacity of the economy.

The significance of investment also lies in the fact that mainly through capital formation innovations, technological advances, new inventions and processes are incorporated in the productive capacity and result in the development of the economy, leading to higher growth of national income; thus they may induce further investments.

Total fixed investment, in real terms, from 14.4 billion drs in 1954 reached 43.4 billion in 1964 and 100 billion drs in 1973 and subsequently was reduced to 86 billion drs in 1977 as Table 5.1 shows (Appendix 1).

In the present study fixed investment has been disaggregated into three broad categories: a) housing investment, b) construction investment (consisting of other buildings and other constructions and works) and c) equipment investment (including transport equipment and machinery and other equipment).

Table 5.3 (Appendix 1) demonstrates that housing investment is of particular importance for the economy as its share in total fixed investment was, in average, 31% between 1959 and 1977. On the other hand construction investment was 41% of total fixed investment in 1959, reached 45% in 1961 and then slowly declined around 33% in 1977. During the same period equipment investment followed an almost steady increase reaching 37% of total fixed investment in 1977.

A more informative picture of the fluctuations of total investment and its categories, emerges from their growth rates from 1954 to 1977, calculated for 5 year's period (except the last one), which are shown in Table 5.2 (Appendix 1).

Construction and equipment investment show a high rate of growth for the period 1954-1958 reflecting the fact that reconstruction of the productive capacity of the country was under way, after the destruction of world war and the subsequent civil war.

For the three following periods, ending with the oil crisis (1959-1963, 1964-1968 and 1969-1973) total fixed investment had an average rate of growth of 7% for each period. The rate of growth of housing investment was around 7% for the first two periods, but decreased to 5.5% for 1969-1973 when the rate of growth of GNP reached its peak.

On the other hand, as the economy was growing, the rate of growth of construction and equipment investment followed opposite paths. The rate of growth of construction investment from 7.9% in 1954-1963 was reduced to 6.2% in 1969-1973. On the contrary the rate of growth of equipment investment from 6.2% in 1959-1963 increased to 8.9% in the last period before the oil crisis (1969-1973).

The rate of growth of total fixed investment almost halved (3.6%) for the period following the increase in the price of oil in 1974 and its consequences on the world economy. This figure (3.6%) conceals the diverse movements in the rates of growth of the different types of investment. Construction and equipment investment showed almost no increase as the corresponding figures of 0.6% and 0.2% for their rates of growth demonstrate(1). At the same time housing investment reached a very high rate of growth of 13.6% (more than doubled from the previous period 1969-1973) demonstrating the attempts of investors to secure their savings in a period of economic crisis and uncertainty.

The effects of the oil crisis on the economy and hence on investment are further reflected in the rate of increase of the implicit deflators for investment categories, reaching an average between 10-12% for this period (Table 5.4, Appendix 1). However a substantial increase of around 8% is also shown in the previous period 1969-1973 when the rate of growth of the GNP increased as well.

Concerning the investment in Greece, mention should be made of the large part of government in the construction investment especially, which exceeded 55% of total construction investment from 1970 to 1977 (Table 5.5, Appendix 1).

As it has been mentioned, investment plays a crucial role in the growth of an economy; thus many theories have tried to determine the factors influencing investment and explain the fluctuations in investment behaviour. A brief summary of the most important of these is given below.

5.2 Investment Theories

5.2.1 Accelerator Models

The origin of the accelerator principle in economics, associated with J. M. Clark, dates back to 1917. According to Clark, the demand for increasing the capital stock is proportional not to the demand for the finished product but to the acceleration of this demand.

The acceleration principle in its formal exposition is based on a number of strong and rigid assumptions. Such is the existence of an optimum production method, resulting in fixed capital/output and labout/output ratios; a fixed output mix; firms increasing their capital stock and not constrained by shortage of funds. In addition, firms always invest sufficiently to bring their capital stock to the required optimum for the current level of production. Hence the actually held capital stock is always equalized to its optimum level.

Under these assumptions the capital stock is related to output by the relation $K_t = bY_t$, where K_t is the capital stock held at the end of each period, Y_t is the output of each period and b is the optimum capital/output ratio. If we lag the above relation by one period and then subtract it we get

$$K_t - K_{t-1} = b(Y_t - Y_{t-1})$$

where $K_t - K_{t-1}$ is net investment in period t undertaken by firms in order to bring their capital to its optimum level. Investment is thus a function of the change in output $I_t = b\Delta Y_t$.

The simple accelerator model has been severely and validly criticized. Its restrictive and unrealistic assumptions cannot be considered as approximating the observed behaviour of firms.

The extensive criticisms of the model led to its gradual modification into the flexible form. The firms are influenced in their investment decision by changes in output but a time lag occurs between these changes and the implementation of new projects. The firms are furthermore inclined to relate investment to changes in output, considered by them as permanent. A strong indication of permanence (which may be represented by a distributed lag) could provide a less uncertain ground for expectations of future demand.

The flexible accelerator model[2] incorporates these insights and may be formally represented as follows:

$$K_t - K_{t-1} \quad \sum_{j=1}^{n} bj \; (Y_{t-k-j} - Y_{t-k-j-1})$$

or

$$I_t = \sum_{j=1}^{n} bj \; \Delta Y_{t-k-j}$$

where K, Y, b have the same meaning as before, k is the gestation time interval and n shows the formation of expectation. The search for the creation of more realistic and flexible models led to stock adjustment models which are also based on the acceleration principle.

5.2.2 Capital Stock Adjustment Models

The stock adjustment model for capital, as this has been exemplified by Goodwin, Chenery, Koyck and others, is based on the concept of the desired or equilibrium capital stock (K*). The basic assumption is that investment is proportional to the difference between the desired and the actual capital held by firms.

The stock adjustment model can be formally presented as

$$I_t = K_t - K_{t-1} \; b(K_t^* - K_{t-1})$$

For various reasons firms, which operate in a complex environment, partially adjust investment to changes in output. This adjustment may be spread over a number of periods and could take the form of a distributed lag. The investment function becomes

$$I_t = K_t - K_{t-1} = b(L) \; (K_t^* - K_{t-1})$$

Desired capital stock may depend on output and possibly on other factors as well. If it is assumed that the desired capital stock is a linear function of output (Y), that is

$$K^* = a_o + a_1 \, Y_t$$

and substituted for K* in the stock adjustment model, the investment function is

$I_t = K_t - K_{t-1} = b \; (a_o + a_1 \, Y_t - K_{t-1})$ or, with a distributed lag effect

$$I_t = b(L) \; (a_o + a_1 \, Y_t - K_{t-1})$$

The association of this function with the acceleration principle which emphasized the relation of investment to output changes can be demonstrated as follows(3).

We start from the relation

$$K_t - K_{t-1} = b \; (L) \; (K_t^* - K_{t-1})$$

Using the lag operator and rearranging terms we get

$$K_t - LK_t + Lb(L)\, K_t = b(L)\, K_t^*$$

$$(1-L + Lb(L))\, K_t = b(L)\, K_t^*$$

and $$K_t = \frac{b(L)}{1-L+Lb(L)} K_t^*$$

or denoting $\frac{b(L)}{1-L+Lb(L)} = Z(L)$ we get

$$K_t = Z(L) K_t^*$$

Lagging the above equation by one period and subtracting we arrive at the investment function

$$I_t = K_t - K_{t-1} = Z(L)\ (K_t^* - K_{t-1}^*)$$

Assuming again a linear relation between desired capital stock and output $K_t^* = a_o + a_1\, Y_t$ the investment is related to changes in output, its form being

$$I_t = K_t - K_{t-1} = a_1\, Z(L)\, \Delta Y_t$$

One of the theoretical explanations for the flexible stock adjustment model had been suggested by Eisner and Strozt and is based on a cost adjustment approach(4). According to this explanation, increasing costs of adjustment (in the sense that doubling investment incurs more than double costs) would imply that an optimal policy rule for firms is that investment in any period should partially close the gap between the desired and actually held capital stock.

This model has been empirically supported by numerous studies that have used it in various extended forms.

5.2.3 Neoclassical Theory

The main exponent of a theory of investment behaviour of firms based on the neoclassical theory of capital accumulation is D. W. Jorgenson. He argues that the neoclassical theory of capital, as stated for example by I. Fisher, requires that a firm should choose production plans in such a way as to maximize utility over time.(5) Combined with technological and economic conditions of production and consumption, this assumption will lead to the maximization of the present value of the firm as the criterion for optimal capital accumulation. Furthermore, demand for capital is not assimilated with investment demand.

In the short run the determination of investment is based on the lagged time reaction of firms to changes in the demand for capital. This means that by their investment behaviour the firms adjust their capital stock to its optimum level.

The present value of the firm is defined as the integral of discounted future revenues, less discounted future expenditure on both current and capital accounts. Expenditure includes direct taxes; all prices, including the interest rate, are assumed fixed.

$$W = \int_{0}^{\infty} e^{-rt} (R_t - DT_t)\, dt$$

where W is the present value of the firm R, net revenue before taxes, and DT direct taxes. The present value W is maximized subject to two constants. First, a production function relating flows of capital (K) and labour services (L) to the flow of output (Q) $F(Q,L,K) = 0$. Second, that the rate of growth of capital stocks (K) is equal to investment (I) less replacement, that is $\dot{K} = I - \delta K$ where δ is the rate of depreciation.

Net revenue (R) is defined as

$R = pQ - wL - qI$, where p is the price of output, w the wage rate and q the price of capital goods.

Direct taxes (DT) are calculated as

$$DT = n\ [pQ - wL - (v\delta q + wrq - x\dot{q})K]$$

where n is the rate of direct taxation of income defined for tax purposes, and v, w and x the proportion of depreciations, interest rates and capital losses respectively, which could be charged against income for tax purposes. The maximization of the present value of the firm subject to these two constraints gives the marginal productivity conditions for labour and capital as

$$\frac{\theta Q}{\theta L} = \frac{w}{p} \quad \text{and}$$

$$\frac{\partial Q}{\partial K} = \frac{q\left[\frac{1-uv}{1-u}\delta + \frac{1-uw}{1-u}r - \frac{1-ux}{1-u} \cdot \frac{\dot{q}}{q}\right]}{p} = \frac{c}{p}$$

where $-\frac{\dot{q}}{q}$ is the rate of capital losses.

The numerator of the second fraction c, called the user cost of capital, is the shadow price or implicit rental price of one unit of capital service for each period of time. The rental price may be employed by firms in calculating an optimum path for capital accumulation.

So the level of output and the imputs necessary for its production, both current and capital, are determined by the production function and the marginal productivity conditions[6].

Further, if we assume that the production function is of the Cobb-Douglas form $Q = AK^{a}L^{d}$ and employ the above productivity condition $\frac{\partial Q}{\partial K}$, the desired capital stock function is $K^{*} = a\,\frac{pQ}{c}$ where a is the elasticity of output with respect to capital.

Assuming also that investment for new projects is equal to the difference between the desired capital stock and the capital stock actually held plus the backlog of uncompleted projects, this implies that net investment can be represented by a distributed lag of the first differences in desired capital. If we add the replacement investment assumed as a constant proportion of capital stock (δK), the estimated investment function is derived

$$I_t = b(L)\ [K_t^{*} - K_{t-1}^{*}] + \delta K_t$$

where L is the lag operator.

Substituting for the equation of desired capital stock $K^{*} = a\,\frac{pQ}{c}$ we get the investment function

$$I_t = b(L)\ (a\Delta\ \frac{pQ}{c}) + \delta K_t$$

The neoclassical theory as developed by Jorgenson, has been criticized for its strong simplifying assumptions. It ignores the effects of risk and uncertainty, the expectations are static, and it implicitly accepts that firms aim at profit maximization, which has been strongly disputed. It has also been criticized for assuming uniform effects on investment by changes in the different variables included in the rental price of capital.

5.2.4 Sources of Funds and Financial Cost

If firms were operating in perfect capital markets, entrepreneurs would have no preference for using their own or borrowed funds, because the opportunity cost of using internal funds is equal to the cost of externally obtained ones. From observations on the behaviour of enterprises a preference for the use of internal funds can be concluded. This shows that the imputed cost of using internal funds is less than the cost of borrowed funds. Important sources of internal funds are depreciation allowances, retained after tax profits.

Loans on fixed interest rates, preference shares and equities are the main sources of external finance. The cost of internal funds could be less than that external finance, as in the case of imperfect markets for borrowed funds. Besides, firms have an aversion for borrowing and the accompanying risks. As these various sources of funds are associated with different costs - both monetary and subjective - the rate of investment will be determined up to the point that the rate of returns from investment is equal to the marginal cost of funds. As the internal funds are associated with lower costs, larger amounts of them could lower the financial cost of the firm and increase the demand for investment. In addition, changes in profits might convey information about the profitability of firms and change the expectations about future demand and output. This would lead to higher investment[(7)].

These considerations have led to the inclusion of cashflow, and profits in investment functions for internal funds. External funds are represented by the interest rate to account for their cost and various variables that are used to proxy the debt capacity of the firms.

5.2.5 Tobin's Q Theory of Investment

The principal alternative theory for investment has been provided by Tobin. All the previous models have explained investment in terms of changes in output. This theory, however, uses a portfolio balance approach to determine investment.

Tobin relates investment to the ratio of the market value of existing capital to its replacement cost. This ratio is the Q variable entering investment functions[8]. According to Tobin the factors that make Q depart from unity are firstly lags in capital goods delivery and secondly adjustment costs of investment. When either or both are present, the effect is that the present value of marginal additions to capital stock departs from their current cost.

Roughly interpreted, Q theory relates investment positively to the market value of firms assets and negatively to its replacement cost, that is both investment and Q have a similar response to long run expectations about future profitability, output and prices[9].

5.3 Results of the Analysis

A basic feature of most theories and models is that they employ a measure of output as the main factor explaining investment behaviour. The most commonly used measure is changes in output, since a great number of models can be associated with the flexible acceleration principle, either implicitly or explicitly. Measures of pressure on capacity output are frequently employed and sometimes the level of output is used as well.

Although extensive research on investment has been carried out, none of the models employed has been proved conclusively superior nor able to explain all aspects connected with investment behaviour as it develops over a period of years.

In order to become more manageable to analysis, complicated models, constructed to take into consideration the effects of particular sources of influence on investment, may be obtained at the cost of imposing strong and not easily validated assumptions, (e.g. perfect markets of products and factors, absence of adjustment costs).

Investment by its nature concerns the expansion of productive capacity for the future. Consequently decisions are taken in an uncertain environment, where little or no information exists for the future movements of the main factors influencing investment. In addition there is a lot of disagreement concerning the specification framework for investment functions. Apart from the problems associated with the crucial role of the formation of expectations and the risks undertaken with investments, there are also difficulties stemming from technolgical considerations. These may include problems connected with the assumption of capital homogeneity in many models and the technical characteristics of capital stock.

Capital consists of a large number of different types of equipment goods and structures, and investment for each type may respond to economic changes in different ways. An aggregate investment relation could miss important information which could have otherwise been obtained, if the more realistic assumption of heterogeneity of capital was employed. Another source of disagreement concerns the technical characteristics of installed capital goods. According to putty-putty models, investment is reversible and can be adapted to incorporate new features or to react to changes in the relative prices of factor inputs. On the contrary, in putty-clay models firms responding to economic changes (or to expectations about them) can choose among investment goods exhibiting different technical characteristics before their instalment. After they have been installed the technical characteristics are fixed and the capital-labour ratio is also fixed[10]. Of equal importance, are the issues related to the influence of financial factors on investment decisions, such as the choice and the relevant merits of external and internal finance, the role of profits on investment behaviour and the costs of funds. All these strongly debated issues indicate the complexity of investment behaviour. It has been argued that no model has managed to capture convincingly that complexity in its entirety. They have at best approximated it and give answers to some specific aspects of investment[11].

This empirical analysis is conducted in the framework of the flexible stock adjustment models associated with the acceleration principle. No capital variable is used in the estimated equations, as relevant figures do not exist. No attempt was also made to construct a series of capital stock figures from investment which would have been to a large extent arbitrary. Taking into consideration the difficulties of comparing equipment installed in different years and of those associated with the methods of calculating depreciation[12], any such crude measure of capital stock probably would not improve the understanding of investment behaviour but would bias the results. Because of the absence of capital stock figures, no allowance was made to separate the effects of replacement investment.

As it is very difficult in a technologically fast changing world to differentiate in each period the part concerning replacement from a given investment, it can be assumed that the same economic factors determine both new and replacement investment(13).

Formally we assume that firms have a desired level of gross investment (I_t^*) but that there are delayed adjustments of actual gross investment (I_t) to its desired level. That is

5.3.1 $$I_t - I_{t-1} = b(I_t^* - I_{t-1}) \quad 0 < b \leq 1$$

So the change in investment in each period is proportional to the difference between the desired level of investment at current period and actual investment in the previous period; and b is the reaction coefficient. These delays in adjustment occur because of the lags between the emergence of the need to increase capital stock, the appropriation of the necessary funds and the arrangement of the appropriate orders. In addition, there are significant delays in the production and instalment of new equipment and the construction of new buildings.

Solving equation (5.3.1) for investment, we get

5.3.2 $$I_t = bI_t^* + (1-b)\, I_{t-1}$$

Lagging successively the above equation and after substitutions we obtain,

5.3.3 $$I_t = bI_t^* + b(1-b)I_{t-1}^* + b(1-b)^2 I_{t-2}^* + \ldots\ldots$$

or $$I_t = b \sum_{i=o}^{\infty} (1-b)^i I_{t-i}^*$$

So the behavioural assumption of stock adjustment implies that gross investment in current period is a distributed lag of current and past levels of desired investment with weights declining geometrically. The level of desired investment may depend on changes in output (ΔQ) and possibly other factors such as interest rates, tax rates, profits etc.

Assuming that desired investment can be approximated by a linear function of changes in output we derive

5.3.4 $$I_t^* = a_o + a_1 \Delta Q_t + u_t$$

and substituting it in equation (5.3.2) we get the estimated equation

5.3.5 $$I_t = a_o b + a_1 b \Delta Q_t + (1-b)\, I_{t-1} + v_t \quad \text{where} \quad v_t = bu_t$$

In the present study total fixed investment (excluding ships operating overseas) is grouped into three categories from the figures given in the national accounts.

Investment has been divided into: (a) construction investment (CI), which includes buildings and other works and construction; (b) investment in equipment (EI) the sum of transport and machinery equipment; (c) investment in housing (HI).

Total investment includes investment expenditure of both the private and government sectors. As governments objectives and responses to economic and social factors are different from those of the private sector, a better approach would be to estimate different functions for each sector, especially for construction investment where governments share in the period

1970-1977 exceeded 55% (table 5.5 in Appendix 1). But data limitations precluded this attempt, as figures for government investment disaggregated into construction, equipment and housing categories are given from 1970 onwards.

All variables included in the analysis are expressed, unless otherwise stated, in constant terms and are deflated by their corresponding implicit deflators with 1970 the base year. The above equation (5.3.5) is estimated for the three categories of construction, equipment and housing investment. For the last category the variable ΔQ_t, of output changes, has been replaced by changes in personal disposable income (ΔDY_t), as this variable is considered as geared better to income expectations and the resources of households, from which the great bulk of the demand for housing investment arises.

All equations were estimated by ordinary least squares (OLS) and some by generalised least squares allowing for a first order autocorrelation scheme (GLS) as well. The exact process for autocorrelation correction is as described in the previous chapter (Consumption). The two-stage least squares procedure (TSLS) was also used.

The first specification relates the desired level of investment to changes in output. The equation (5.3.5) was estimated for the three investment categories:

$$CI_t = a_o b + a_1 b \Delta Q_t + (1-b) CI_{t-1} + v_t$$
$$EI_t = a_o b + a_1 b \Delta Q_t + (1-b)\ EI_{t-1} + v_t$$
$$HI_t = a_o b + a_1 b \Delta DY_t + (1-b)\ HI_{t-1} + v_t$$

where ΔQ_t is the first differences of the gross national product at factor cost.

The results are given in the following Table 1. Figures in brackets below the estimates of the coefficients are the absolute values of t test statistic at 5 percent level of significance.

These results for all equations from the point of view of the standard statistical tests are quite satisfactory. Their fit is very high; the corrected R^2 ranges from 0.89 for housing investment (5.3.10) to 0.98 for equipment investment (5.3.9). The autocorrelation coefficient (p) is negligible and statistically almost zero (t = 0.23) for construction investment. Its magnitude (-0.35) for both equipment and housing investment is statistically insignificant but exceeds its standard error. The estimated coeffients of output and income changes and the lagged dependent variables are statistically significant exceeding many times their standard errors. As a stringer test the three equations were used to generate forecasts outside the sample period which then were compared with the actual values for investment. For construction and equipment investment forecasts were generated for the three subsequent years (1978-1980) for which data exist. Housing investment forecasts were generated only for the following two years because figures concerning personal disposable income for 1980 have not been given.

Construction investment forecasts were generated using the function estimated by OLS as the estimated autocorrelation coefficient was found statistically zero. It has already been mentioned that the autocorrelation coefficient for equipment and housing investment function is statistically insignificant. As their value exceeds their standard errors almost twice (1.75 and 1.78 respectively), it was decided that forecasts for those

TABLE 1 RESULTS OF ESTIMATION OF INVESTMENT FUNCTION WITH CHANGES IN OUTPUT

No. of equation	Method of estimation	Dependent variable	Estimates of Coefficients: Constant	ΔQ_t	ΔDY_t	lagged dependent variable	auto-correlation coefficient ρ	R^2	$\bar{R}^2$	SEE	DW
5.3.6.	OLSQ	CI	1010.3 (1.35)	0.246 (4.98)		0.834 (20.88)		0.97	0.97	1477.8	1.85 N.A.
5.3.7	GLS	CI	1456.66 (1.76)	0.2408 (4.97)		0.820 (19.36)	0.05 (0.23)	0.97	0.96	1448.5	2.05 N.A.
5.3.8	OLSQ	EI	-117.84 (0.95)	0.214 (4.05)		0.916 (23.84)		0.97	0.97	1648.87	2.58 INC
5.3.9	GLS	EI	-283.05 (0.47)	0.239 (5.01)		0.908 (29.51)	-0.35 (1.75)	0.98	0.98	1600.36	2.19 N.A.
5.3.10	OLSQ	HI	868.86 (0.69)		0.263 (6.20)	0.792 (11.11)		0.90	0.89	2443.08	2.32 N.A.
5.3.11	GLS	HI	341.67 (0.35)		0.274 (6.70)	0.814 (14.58)	-0.35 (1.78)	0.94	0.94	2374.01	2.06 N.A.

two categories should be generated using the estimates corrected for autocorrelation (equations (5.3.9) to (5.3.10)). The forecasts for all investment functions are given in Table 2.

The statistic $Z_1(k) = \sum_{i=1}^{k} (\frac{fi}{\sigma})^2$ (where fi is the forecast error and σ the standard error of estimate) to test for forecast accuracy, is calculated for each investment function. The critical values of the x^2 distribution with 3 and 2 degrees of freedom (k) are 7.815 and 5.992 respectively. The null hypothesis of parameters stability and forecasting accuracy can be accepted for construction investment as the value of $Z_{1(3)}$ statistic 6.182 is less than the critical value (7.815). For the other two functions the test is conclusively against the null hypothesis. The value of Z_1 is 12.163 for equipment and 8.517 for housing investment. Both figures are well outside the critical values, indicating that the present specification for these investment functions is not appropriate. Another factor weighing against this specification for equipment investment is the very slow adjustment of investment to changes in output, as showed by the calculated mean lag, which has a length of about ten years. Despite the controversy about the length of the investment lag which emerged from the empirical work on investment[14] and the fact that in some cases research has indicated that effects from changes in output can last up to five years[15], the above quoted mean lag of 10 years also points out that the specification for equipment investment is rather deficient.

From the theories already summarised it is apparent that, in apart from changes in output, other factors as well contribute to the explanation of investment behaviour. Economic theory indicates possible variables to be included in investment

TABLE 2 FORECASTS IN MILLION DRS. USING EQUATIONS (5.3.6) (5.3.9) and 5.3.11)

Year	Construction Investment			Equipment Investment			Housing Investment		
	Actual	Forecast	Error	Actual	Forecast	Error	Actual	Forecast	Error
1978	27541	30140	2599	33485	33410	-75	30074	25619	-4455
1979	28654	27704	-950	38044	33836	-4208	31572	26266	-5306
1980	24284	26702	2418	38156	34492	-3664	-	-	-
Sum of Absolute Forecasts Errors			5967			7947			9761

functions. Knowledge of the institutional framework in which firms operate could be an additional source of information.

Taking into consideration the limitations of the data and the complexity of investment behaviour, the above model may be enlarged by adding more explanatory variables and attempting to assess their influence on investment. Further it is assumed that a simple linear relation can reasonably approximate the effect of the additional variables included in the estimated equations.

5.4 Relative Prices Effects

The purpose of including the relative price variable in the investment functions was to determine the impact, if any, of the cost of investment goods relative to that of the output price on investment. A measure better than the price of investment goods would be the use of an index of cost of capital services, which could include the effects of depreciation rate, tax rates and allowances and the cost of capital. But for the reasons mentioned earlier (calculation of capital stock and depreciation rates, information necessary for tax rates and allowances) it is decided to use instead the price of investment goods. Given the complicated nature of the user cost of capital variable, by which the interaction of many factors is taken into consideration, the price of investment goods, by which it is replaced is obviously a poor proxy. As prices for investment goods the implicit deflators for construction (PCI), equipment (PEI) and housing investment (PHI) were used. For the price of output and implicit deflator of gross national product at market prices (PGNPM) was employed.

For housing investment equations, its implicit deflator was divided by the consumer price index (CPI) to construct the relative price, as this measures better the cost of living against which households may compare the price of housing investment. Assuming that in equation (5.3.4) the desired gross investment is a linear function of changes in output and relative prices, the estimated equations for each investment category are:

5.4.1 $$C_t = a_o b + a_1 b \Delta Q_t + a_2 b \frac{PCI}{PGNPM}_t + (1-b)\ CI_{t-1} + v_t$$

5.4.2 $$EI_t = a_o b + a_1 b \Delta Q_t + a_2 b \frac{PEI}{PGNPM}_t + (1-b)\ EI_{t-1} + v_t$$

5.4.3 $$HI_t + a_o b + a_1 b \Delta DY_t + a_2 b \frac{PHI}{CPI}_t + (1-b)\ HI_{t-1} + v_t$$

Contrary to the expectations for construction and housing investment the coefficient for relative prices has a positive sign. Although in equipment investment the coefficient of relative prices has the correct sign, it has no explanatory power. It is statistically insigificant and less than its standard error as can be seen below:

5.4.4 $$EI_t = \underset{(0.46)}{2985.62} + \underset{(3.99)}{0.2207}\Delta Q_t - \underset{(0.49)}{32.42}\ \frac{PEI}{PGNPM}_t + \underset{(21.03)}{0.926}\ EI_{t-1}$$

$$R^2 = 0.97 \qquad \bar{R}^2 = 0.97 \qquad DW = 2.57 \text{ INC} \qquad SEE = 1\,681.1$$

and when this equation was corrected for autocorrelation no important change was found.

Contrary to the theoretical considerations, no influence of relative prices on investment behaviour has been found. This cannot be interpreted as suggesting that investment is relatively insensitive to price changes but it probably reflects the fact that the price of investment goods, as it has been used, is a poor proxy for the cost of capital services.

5.5 Cost of Finance and Availability of Credits

As mentioned before, there is a strong debate about the influence of financial factors, such as the availability of internal funds, the cost of external finance and the role they play on investment behaviour. Stock adjustment models have been often criticised for ignoring the influence of such factors on investment[16]. One way to include financial variables is to follow the above mentioned neoclassical model. In this model financial variables play a specific role in determining the optimum capital stock. This approach has been criticised on the grounds that influencial variables have been inflexibly specified and included in investment functions through the user cost variable[17]. Another way is to include various financial variables in the estimated functions and experiment with them[18]. Financial variables play a significant role in determining investment rate; it can be argued that firms may adjust existing capital stock to its desired level faster if, ceteris paribus, financial factors, such as availability of funds, are favourable. As their exact effects cannot be adequately specified it may be better to approximate them by including financial variables linearly in the investment functions.

Higher interest rates will increase the cost associated with investment projects in respect with their expected revenue. At the same time they may also create or aggravate already existing liquidity problems of the firms leading to decreasing the rate of investment. Firms have to obtain the necessary funds to finance investment projects, which can raise from different sources. For not advanced economically countries the majority of firms, usually of family type ownership, are comparatively small and they have limited capacity to generate adequate internal funds by retaining profits. In addition capital markets are not well developed and it is difficult for firms to raise funds by shares or equities. Consequently, borrowing on fixed interest rates is the main source to obtain funds for investment.

The capacity of firms to borrow is limited by factors such as the magnitude of firms assets, expectations about future prospects as reflected in their profitability and the amount already borrowed, because the total cost of funds will increase when the amount borrowed increases due to the increasing risks for lenders.

Because of the great importance of investment for the growth and development of the economy, governments may try to induce firms to invest by suitable tax policies or measures to facilitate borrowing. These measures could, ceteris paribus, result in increasing the amount of retained profits, reduce the actual cost of funds, enlarge the capacity of firms to borrow and generally to have a positive influence on investment.

To account properly for all these influences, a detailed knowledge of the various policy measures for investment applied at a more disaggregated level of analysis, would be required. In addition data concerning firms earnings, their internal funds and the capacity to borrow are inadequate and usually impossible to obtain.

According to the view stressing the importance of financial factors, the cost of funds is measured by the interest rate in investment functions. To account for the availability of funds and the capacity of firms to borrow, variables such as profits, cash-flow measures and the ratio of debts to firms assets have been frequently included as well.

For the reasons mentioned above it was decided to use the banks and lending institutions credits as a proxy for the influences of these variables.

Assuming furthermore that effect of these factors on investment can be approximated by a linear relation the equation (5.3.4) of desired investment has been modified by the inclusion of interest rates (R_t) and loans (LO_t). After substitution for I_t^* in equation (5.3.2) we finally obtain the equation estimated for the three investment categories:

5.5.1 $$I_t = a_o b + a_1 b \Delta Q_t + a_2 b R_t + a_3 b LO_t + (1-b) I_{t-1} + v_t$$

The interest rate for long term loans (RL) and the total of outstanding bank credits have been used for R_t and LO_t respectively.

Loans have been deflated in each equation by the implicit price deflator of the investment category estimated. For housing investment in apart from the long term interest rate (R_t) the discount rate was also used to as a proxy for short term finance.

Consequently the estimated equation (5.5.1) for each investment category has the form:

5.5.2 $$CI_t = a_o b + a_1 b\Delta Q_t + a_2 bR_t + a_3 b \frac{LO}{PCI}_t + (1-b)\ CI_t + v_t$$

5.5.3 $$EI_t = a_o b + a_1 b\Delta Q_t + a_2 bR_t + a_3 b \frac{LO}{PEI}_t + (1-b)\ EI_{t-1} + v_t$$

5.5.4 $$HI_t = a_o b + a_1 b\Delta DY_t + a_2 bR_t + a_3 b \frac{LO}{PHI}_t + (1-b) HI_{t-1} + v_t$$

First the above equations were estimated by including R_t and LO_t successively in each of them in order to determine the separate influence of the various factors, on investment, for which these two variables account for. Then, the two variables, were included together in an attempt to assess their possible interactions and simultaneous effect on investment behaviour. The results of the inclusion of interest rates are presented in the following Table 3.

As the results in the Table show interest rates are not a very important factor in explaining investment behaviour. In housing investment its coefficient has the wrong sign, while, for the reasons stated above its influence should have been negative. In the other two investment functions the coefficient of interest rate has the expected negative sign. But for equipment investment it is statistically insignificant and less than its standard error. In construction investment while the coefficient is also insignificant the value of t statistic is in excess of one, regardless of the estimation procedure employed.

TABLE 3 INVESTMENT RESULTS WITH INTEREST RATE

No. of equation	Method of estimation	Dependent variable	estimates of coefficients					auto-correlation coefficient	R^2	$\bar{R}^2$	SEE	DW
			Constant	ΔQ	ΔDY	R	lagged dependent variable	ρ				
5.5.5	OLS	CI	4286.98 (2.09)	0.220 (4.42)		-338.34 (1.70)	0.851 (21.62)		0.978	0.97	1411.63	1.92 N.A.
5.5.6	GLS	CI	4214.07 (2.16)	0.226 (4.60)		-346.95 (1.58)	0.835 (21.05)	-0.05 (0.23)	0.978	0.97	1398.57	1.96 N.A.
5.5.7	TSLS	CI	3303.3 (1.51)	0.258 (4.36)		-289.12 (1.19)	0.834 (19.54)				1434.54	2.05 N.A.
5.5.8	OLS	EI	1274.6 (0.49)	0.20 (3.34)		-168.5 (0.56)	0.929 (20.72)		0.977	0.97	1677.85	2.59 INC
5.5.9	GLS	EI	868.4 (0.42)	0.223 (4.00)		-137.8 (0.58)	0.92 (24.50)	-0.35 (1.75)	0.987	0.98	1628.6	2.20 N.A.
5.5.10	OLS	HI	-2564.17 (0.71)		0.282 (6.10)	413.67 (1.01)	0.775 (10.59)		0.90	0.89	2441.91	2.47 INC
5.5.11	GLS	HI	-3191.1 (1.22)		0.306 (6.91)	417.28 (1.41)	0.792 (14.67)	-0.45 (2.36)	0.95	0.94	2319.18	2.19 N.A.

While these results are in line with the evidence that investment decisions are relatively insensitive to the rate of interest[19] it should also be taken into consideration that, without suitable modifications, interest rate, as it is used in this analysis may not reflect properly the cost of funds. It is also probable that interest rates movements, change firms expectations and consequently their decisions, slowly.

At the same time the relative importance of interest rates on construction investment may be attributed to the longer service life of this type of investment, which requires commitment of larger funds by the firms with the associated increasing costs. The absence of autocorrelation of equation (5.5.5) was confirmed when it was re-estimated for autocorrelation; as the table shows the autocorrelation coefficient (in equation 5.5.6) is negligible and statistically insignificant ($t = 0.23$). The same equation was subsequently estimated by the TSLS procedure to account for simultaneity. The summary statistics are similar to those of OLS estimation and the Durbin-Watson statistic points to the absence of autocorrelation (equation 5.5.7).

The coefficient of output changes increased from 0.22 to 0.257 and that of interest rate change from -338.34 to -289.21; although the value of the t statistic decreased, it still exceeded one giving grounds for retaining this variable in the equation. When this equation (5.5.7) was tested for forecasting accuracy it was found to perform better than the previous ones. The $Z_1(3)$ statistic has the value 4.339 (critical value 7.815) which is the lower of all tested functions of construction investment; the sum of forecasting errors dropped to 4.3 billion drs. As the standard error of estimate of equation (5.5.7) is almost similar to the one of equation (5.5.5), and its Durbin-Watson statistic points to the absence of auto-correlation, the first equation was preferred.

The equations (5.5.2) to (5.5.4) were estimated by excluding R_t in order to examine the influence of loans on investment behaviour. The results for the three investment categories are as follows:

5.5.12 $$CI_t = \underset{(1.41)}{1183.96} + \underset{(4.45)}{0.237}\Delta Q_t + \underset{(0.49)}{0.008}\frac{LO}{PCI}_t + \underset{(7.83)}{0.789}\, CI_{t-1}$$

$R^2 = 0.975$ $\bar{R}^2 = 0.97$ SEE = 1506.59 DW = 1.75 N.A.

5.5.13 $$EI_t = \underset{(0.28)}{225.13} + \underset{(3.12)}{0.18}\Delta Q_t + \underset{(1.36)}{0.046}\frac{LO}{PEI}_t + \underset{(3.62)}{0.669}\, EI_{t-1}$$

$R^2 = 0.978$ $\bar{R}^2 = 0.97$ SEE = 1613.9 DW = 2.26 N.A.

5.5.14 $$HI_t = \underset{(2.12)}{1908.7} + \underset{(6.98)}{0.219}\Delta DY_t + \underset{(4.62)}{0.062}\frac{LO}{PHI} + \underset{(3.67)}{0.377}\, HI_{t-1}$$

$R^2 = 0.95$ $\bar{R}^2 = 0.947$ SEE = 1720.13 DW = 2. 46 INC

5.5.15 $$CI_t = \underset{(2.13)}{3146.36} + \underset{(3.17)}{0.159}\Delta Q_t + \underset{(1.87)}{0.038}\frac{LO}{PCI}_t + \underset{(4.65)}{0.592}\, CI_{t-1}$$

$\underset{(2.36)}{p = 0.45}$ $R^2 = 0.91$ $\bar{R}^2 = 0.90$ SEE = 1443.31 DW = 2.06 N.A.

5.5.16 $$EI_t = \underset{(0.68)}{-57.93} + \underset{(3.45)}{0.215}\Delta Q_t + \underset{(0.79)}{0.0246}\frac{LO}{PEI}_t + \underset{(4.68)}{0.779}\, EI_{t-1} \quad p = \underset{(1.25)}{-0.258}$$

$R^2 = 0.986$ $\bar{R}^2 = 0.98$ SEE = 1620.7 DW = 2.14 N.A.

$$5.5.17 \qquad HI_t = \underset{(2.3)}{1277.59} + \underset{(9.13)}{0.251}\Delta DY_t + \underset{(4.80)}{0.049}\frac{LO}{PHI}_t + \underset{(5.89)}{0.471}\,HI_{t-1} \quad p = \underset{(2.65)}{-0.492}$$

$$R^2 = 0.979 \quad \bar{R}^2 = 0.976 \quad SEE = 1624.48 \quad DW = 2.36 \text{ N.A.}$$

For construction investment the coefficient of loans has the right positive sign, but it is statistically insignificant and less than its standard error (t = 0.49). The existence of considerable autocorrelation in the residuals was revealed when this equation was estimated by generalised least squares; the autocorrelation coefficient with a value of 0.45 was statistically significant. The equation (5.5.15) compares unfavourably with the equation (5.5.5) which includes the interest rate instead of loans. It has a lower corrected $\bar{R}^2$ 0.90 and a higher standard error of estimate of 1443.31, while the corresponding figures for (5.5.5) are 0.97 and 1411.63 respectively. In addition the hypothesis of parameter stability cannot be accepted for equation (5.5.15). When the Z_1 statistic is calculated its value of 13.211 is well out above the critical value of 7.815; for the equation (5.5.5) the respective value is 4.774. These results indicate that the equation (5.5.15) which includes loans, cannot explain adequately construction investment.

When loans are used as explanatory variable for equipment investment the results point to a direction opposite to those for construction investment. As can be seen from the above results, when the equation for equipment investment was estimated by OLS the coefficient for loans has had the right sign; although statistically insignificant, its magnitude exceeded its standard error. Its absolute t value slipped below one (t = 0.79), when the equation was estimated for a first order autocorrelation casting doubts about the relative strength of the relation between equipment investment and loans, although the magnitude of the autocorrelation coefficient is neither large ($p = -0.258$) nor significant ($t = 1.25$). Furthermore, the estimation of this function by TSLS pointed to similar conclusions.

The main impact of including the loans variables in the equipment investment was on the magnitude of the coefficent of the lagged dependent variable (EI_{t-1}). In all the previous specifications the magnitude of the coefficient of EI_{t-1} exceeded 0.90, while in the one just examined the magnitude has been reduced to 0.779 (equation 5.5.16). These results point to a faster response of equipment investment to changes in output and the implied mean lag is about 3.5 years. This figure is more plausible for this type of investment than for those, previously found, which exceeded 10 years. These findings could suggest, although tentatively, that the inclusion of loans variable has captured some of the effects of the above mentioned factors for which it has been used as a rather imperfect proxy.

Another factor pointing to this conclusion is the parameters stability which is exhibited by this specification. When the equation (5.5.16) was tested for forecasting accuracy, the Z_1 statistic had a value of 5.53 (critical value 7.815) compared with a value of 12.163 of the function without the loans variable (equation 5.3.9). At the same time the sum of absolute forecasting errors for three years dropped from 7.9 to 6.2 billion dollars.

On the other hand, when the housing investment function was estimated by OLS, the coefficient of loans variable was statistically significant, its magnitude exceeding more than four times its standard error ($t = 4.62$). At the same time the Durbin-Watson statistic was in the inconclusive region (2.468), pointing to the possible presence of significant autocorrelation in the residuals. When the equation was re-estimated for autocorrelation a negative and significant autocorrelation coefficient of magnitude -0.492 was found (equation 5.5.17). The coefficient of loans was again highly significant. In addition, when it was compared with the corresponding equation without loans (5.3.11) it shows a better fit, as its $\bar{R}^2$ increased from 0.94 to 0.976 and a considerable decrease in the standard error of estimate from a value of 2374.01 to 1624.48. The estimates from TSLS are near those from ordinary least squares (equation 5.5.14) as can be seen from the following results:

$$5.5.18 \qquad HI_t = \underset{(2.04)}{1869.57} + \underset{(6.67)}{0.216}\Delta DY_t + \underset{(4.17)}{0.0595}\,\frac{LO}{PHI} + \underset{(3.65)}{0.399}\,HI_t$$

$$SEE = 1723.44 \qquad DW = 2.49 \text{ INC}$$

But as the Durbin-Watson statistic is in the inconclusive region the equation (5.5.17) corrected for autocorrelation has been preferred. This improvement of the equation (5.5.17) compared with equation (5.3.11) in explaining better housing investment has not been accompanied by a similar improvement in forecasting accuracy; both equations failed the test for parameter stability.

The $Z_{1(2)}$ statistic for equation (5.5.12) has a value of 20.638 well in excess of the critical value 5.992.

Estimating the functions for the three investment categories, including both interest rates and loans, did not result in any significant improvement as can be seen from the following Table 4.

In housing investment the coefficient for interest rate has now a negative sign but statistically is zero. When the discount rate (DIRA) was used not any important difference was found; a typical result is the equation (5.5.25) presented in Table 4.

In equipment investment, when estimated by OLS the coefficient of loans is statistically significant in one tail test (t = 1.79) while the t absolute value of the coefficient of interest rate barely exceeds its standard error. No significant autocorrelation was found in the residuals, as the autocorrelation coefficient is not only of low magnitude but also less its standard error. But when this equation was estimated by TSLS, both coefficients shrank and their t values were less than one. It should also be mentioned that the forecasting accuracy of equation (5.5.22) as it is reflected in the Z_1 statistic (with a value 6.396) is less than that of the equation with loans (5.5.16).

In the construction investment both coefficients of loans and the interest rate are statistically significant, whether the function is estimated by OLS or is corrected for autocorrelation; its presence is not a serious problem however as the coefficient of autocorrelation is statistically insignificant. When it was estimated by TSLS (equation 5.5.21) to account for simultaneity bias, the coefficient of interest rate remained statically significant (t = 2.21) while that for

TABLE 4 INVESTMENT FUNCTIONS WITH INTEREST RATES AND LOANS

No. of equation	Method of estimation	Dependent variable	estimates of coefficients: Constant	ΔQ	ΔDY	lagged dependent	R	DIRA	LOANS	auto correlation coefficient ρ	R^2	$\bar{R}^2$	SEE	DW
5.5.19	OLS	CI	10842.0 (4.03)	0.114 (2.14)		0.55 (5.44)	-1017.19 (3.70)		0.059 (3.14)		0.985	0.98	1165.58	1.55 INC
5.5.20	GLS	CI	12162.0 (4.33)	0.089 (1.83)*		0.486 (4.70)	-1091.95 (3.69)		0.068 (3.66)	0.25 (1.23)	0.97	0.96	1110.58	1.80 N.A.
5.5.21	TSLS	CI	8241.71 (2.40)	0.172 (2.43)		0.636 (5.23)	-768.02 (2.21)		0.040 (1.70)				1209.36	1.85 N.A.
5.5.22	OLS	EI	3675.87 (1.31)	0.131 (1.91)*		0.594 (3.12)	-400.23 (1.28)		0.066 (1.79)*		0.98	0.97	1587.1	2.19 N.A.
5.5.23	GLS	EI	2716.16 (1.05)	0.163 (2.36)		0.694 (3.86)	-312.7 (1.09)		0.045 (1.30)	-0.20 (0.95)	0.98	0.98	1614.1	2.10 N.A.
5.5.24	GLS	HI	2124.69 (0.93)		0.242 (6.84)	0.456 (5.15)	-92.94 (0.38)		0.052 (4.22)	-0.45 (2.36)	0.978	0.97	1665.7	2.34 INC
5.5.25	OLS	HI	2909.97 (1.60)		0.210 (6.09)	0.364 (3.41)		-111.96 (0.63)	0.064 (4.58)		0.95	0.94	1747.5	2.42 INC

* Indicates significance in one tail test.

loans became statistically insignificant but it exceeded its standard error (t = 1.70). The mean lag implied by the estimates of the lagged dependent variable in equations (5.5.19) and (5.5.20) is around one year which is rather short for this type of investment, while the mean lag of around two years implied by the TSLS estimates (equation 5.5.21) seems more plausible. The Z_1 statistic for equation (5.5.21) has a value of 10.503 which is larger than the critical value 7.815. This result casts doubts on this specification which otherwise could have been preferred. The sum of the absolute forecasting error has also been increased from 4.3 billions (equation 5.5.7) to 6.7 billion drs. Another feature casting doubts on this specification (equation 5.5.21) is the large magnitude of the constant term almost one third of the mean value of construction investment. While the main explanatory variables suggested by investment theories have been accommodated in this specification, the magnitude of the constant term implies that a large amount of investment will still take place which is not accounted by them.

Relative prices, when included in the equations have not any significant influence. In all three categories the coefficient of relative prices was statistically insignificant and less its standard error. It has the correct sign (suggested by economic theory as it has been already mentioned) for equipment and housing, and a positive one for construction investment. The only exception was the equation for equipment investment, in which in addition to changes in output and relative prices, interest rates and loans were also included; in this case all variables had the correct sign, but the crucial variable of changes in output became statistically insigificant and when the equation was estimated by TSLS, this coefficient turned to negative. It also had a very large constant term well in excess of the mean value of equipment investment (19.3 billion).

$$CI_t = \underset{(0.79)}{6634.57} + \underset{(2.10)}{0.129}\Delta Q_t - \underset{(3.47)}{1094.22}\, R_t + \underset{(2.49)}{0.053}\,\frac{LO}{PCI} +$$

$$\underset{(5.03)}{0.536}\, CI_{t-1} + \underset{(0.53)}{57.8}\,\frac{PCI}{PGNPM} \quad R^2 = 0.98 \quad \bar{R}^2 = 0.98$$

$$SEE = 1189.3 \quad DW = 1.68 \text{ INC}$$

$$EI_t = \underset{(1.05)}{10144.8} + \underset{(3.24)}{0.197}\Delta Q_t - \underset{(0.99)}{359.87}\, R_t + \underset{(16.29)}{0.966}\, EI_{t-1} - \underset{(0.95)}{76.15}\,\frac{PEI}{PGNPM}$$

$$R^2 = 0.97 \quad \bar{R}^2 = 0.97 \quad SEE = 1681.3 \quad DW = 2.61 \text{ INC}$$

$$EI_t = \underset{(0.69)}{4371.2} + \underset{(3.14)}{0.186}\Delta Q_t + \underset{(1.41)}{0.049}\,\frac{LO}{PEI} + \underset{(3.56)}{0.668}\, EI_{t-1} - \underset{(0.66)}{43.11}\,\frac{PEI}{PGNPM}$$

$$R^2 = 0.97 \quad \bar{R}^2 = 0.97 \quad SEE = 1638.1 \quad DW = 2.23 \text{ N.A.}$$

$$EI_t = \underset{(2.58)}{25219.0} + \underset{(1.32)}{0.085}\Delta Q_t - \underset{(2.58)}{969.8}\, R_t + \underset{(2.81)}{0.104}\,\frac{LO}{PEI} -$$

$$\underset{(2.71)}{179.2}\,\frac{PEI}{PGNPM} + \underset{(2.28)}{0.484}\, EI_{t-1}$$

$$R^2 = 0.98 \quad \bar{R}^2 = 0.98 \quad SEE = 1428.3 \quad DW = 2.04 \text{ N.A.}$$

$$HI_t = \underset{(0.70)}{7541.4} + \underset{(7.13)}{0.241}\Delta DY_t + \underset{(2.63)}{0.0609}\,\frac{LO}{PHI} - \underset{(0.58)}{83.98}\,\frac{PHI}{CPI} +$$

$$\underset{(5.05)}{0.507}\, HI_{t-1} \quad \rho = \underset{(2.76)}{-0.507} \quad R^2 = 0.98 \quad \bar{R}^2 = 0.97$$

$$SEE = 1655.2 \quad DW = 2.31 \text{ N.A.}$$

$$HI_t = \underset{(0.72)}{8082.7} + \underset{(5.81)}{0.234} \Delta DY_t + \underset{(2.56)}{0.062} \frac{LO}{PHI} - \underset{(0.31)}{76.7} R_t -$$

$$\underset{(0.55)}{82.09} \frac{PHI}{CPI} + \underset{(4.60)}{0.497} HI_{t-1} \quad p = \underset{(2.70)}{-0.50}$$

$R^2 = 0.98 \quad \bar{R}^2 = 0.97 \quad SEE = 1700.9 \quad DW = 2.28$ INC.

5.6 Specifications with Levels In Output, Income and Government Deficit

It is well established that households play an important role in determining the level of demand for housing investment. Both theory and empirical research concerning the behaviour of households have indicated, that their expenditure depends on their total resources and on expectations about future incomes. Expectations are mainly modeled as a weighted average of current and past incomes.

The results for housing investment mentioned in previous sections cast some doubts on the use of the flexible stock adjustment model (even when it has been enlarged with additional variables) in explaining adequately this investment category. Although these results satisfy the standard summary statistics, they also indicate the presence of significant autocorrelation in the residuals (the autocorrelation coefficient exceeds 0.50 in some cases). At the same time none of them forecasts satisfactorily outside the sample period; for all of them the value of Z_1 statistic is always significant and exceeds the critical value of 5.992 (casting doubts on these specifications, although it is known that this statistic is biased against the null hypothesis in small samples).

So it was decided to apply to this category of investment the model employed for consumption expenditures, assuming that housing investment depends on expected income and expectations follow a simple adaptive process. For the income variable the personal disposable income (DY) was used deflated by the consumer price index. The results were as follows:

5.6.1 $$HI_t = \underset{(0.64)}{1048.15} + \underset{(3.74)}{0.065}\ DY + \underset{(0.57)}{0.124}\ HI_{t-1}$$

$$R^2 = 0.83 \quad \bar{R}^2 = 0.81 \quad SEE = 3204.4 \quad DW = 1.48 \text{ N.A.}$$

These compare unfavourably with the results corresponding to the flexible stock adjustment model (5.3.10). The summary statistics are considerably inferior to those of equation (5.3.10). The corresponding figures for $\bar{R}^2$ and SEE being 0.89 and 2443.08 respectively. The coefficient of lagged dependent variable is statistically insignificant and less than its standard error. When the equation was re-estimated to allow for a first order autocorrelation scheme the results show that this specification cannot be accepted, as the coefficient of lagged dependent variable has a negative sign (it thus violates the assumption that $0 \leq b \leq 1$).

$$HI_t = \underset{(2.08)}{-28700.5} + \underset{(4.73)}{0.192}\ DY_t - \underset{(2.11)}{0.349}\ HI_{t-1} \qquad \underset{(9.68)}{p = 0.90}$$

$$R^2 = 0.54 \quad \bar{R}^2 = 0.50 \quad SEE = 2886.3 \quad DW = 1.43 \text{ N.A.}$$

Further attempts to use this specification adding some relevant variables were not successful in providing a function explaining housing investment more satisfactorily than that employed in previous sections, as the following sample of some of the estimated equations reveals.

$$HI_t = \underset{(2.18)}{42056.5} + \underset{(4.31)}{0.131DY} - \underset{(2.15)}{599.9}\,\frac{PHI}{CPI} + \underset{(0.96)}{0.219HI_{t-1}} \quad \rho = \underset{(0.89)}{0.186}$$

$R^2 = 0.82$ $\bar{R}^2 = 0.79$ SEE = 2883.9 DW = 1.82 N.A.

$$HI_t = \underset{(2.89)}{10647.1} + \underset{(5.01)}{0.0793DY} - \underset{(2.83)}{1266.6\,R_t} + \underset{(0.63)}{0.0067\,HI_{t-1}}$$

$R^2 = 0.88$ $\bar{R}^2 = 0.86$ SEE = 2757.4 DW = 1.49 INC

$$HI_t = \underset{(2.34)}{12002.4} + \underset{(0.50)}{0.044DY} - \underset{(2.67)}{1240.1\,R_t} + \underset{(0.38)}{0.047}\,\frac{LO}{PHI} + \underset{(0.26)}{0.067\,HI_{t-1}}$$

$R^2 = 0.88$ $\bar{R}^2 = 0.85$ SEE = 2821.17 DW = 1.60 INC

$$HI_t = \underset{(2.56)}{49426.0} + \underset{(1.31)}{0.143DY} - \underset{(0.09)}{0.013}\,\frac{LO}{PHI} + \underset{(1.31)}{0.329\,HI_{t-1}} - \underset{(2.41)}{709.5}\,\frac{PHI}{CPI}$$

$R^2 = 0.87$ $\bar{R}^2 = 0.86$ SEE = 2899.7 DW = 1.76 N.A.

The overall picture emerged is that equations based on this specification do not explain satisfactory the housing investment. Individual coefficients are statistically insigificant and many of them with a wrong sign. Summary statistics are always inferior to those obtained from equations based on the stock adjustment principle.

When current disposable income and its first differences were included together in an equation or, instead of them, GNP and its changes were used, the sign of the level variable was frequently negative and the general picture of these equations followed the same disappointing pattern.

Construction Investment and Public Deficit

From the Table 5.5 (in Appendix 1) it can be seen that from 1970 when disaggregated data for government investment were given in the national accounts, the largest bulk of construction investment has been undertaken by the state. Government construction investment constituted 63.25% of the total construction investment in 1970. This percentage declined to 55.61% in 1977, while the governments equipment investment is comparatively a small percentage (between 10 and 20% in the same period) of the total and a negligible one for housing investment (1-1.5%).

On the assumption that public deficit is mainly used to finance government investment, it was decided that it should be included linearly in the equation for construction investment in an attempt to find out if it has any significant explanatory power. In general government competes with enterprises to attract savings, in order to finance its deficit. Thus the amount of savings available for financing investment is decreased. An increase in public deficit should have a negative effect on investment. In this case, as the assumption is that government uses its deficit mainly to finance investment in construction a positive sign is expected.

When public deficit (PD) was included in the equation its coefficient had a negative sign and statistically was insignificant ($t = 0.29$).

$$CI_t = 993.14 + 0.291\Delta Q_t - 0.033\ PD + 0.857\ CI_{t-1}$$
$$(1.30) \quad (4.54) \quad (0.29) \quad (9.90)$$

$$R^2 = 0.974 \quad \bar{R}^2 = 0.973 \quad SEE = 1512.8 \quad DW = 1.89 \text{ N.A.}$$

It has been found (equation 5.5.7) that the interest rate has a mild influence on construction investment, and the above equation was re-estimated by including the public deficit variable and gave the following results

$$CI_t = 6895.27 + 0.228\Delta Q_t - 685.57\ R_t + 0.197\ PD + 0.733\ CI_{t-1}$$
$$(2.44) \quad (4.63) \quad (2.15) \quad (1.31) \quad (7.48)$$

$$R^2 = 0.98 \quad \bar{R}^2 = 0.975 \quad SEE = 1385.5 \quad DW = 1.90 \text{ N.A.}$$

The inclusion of interest rate resulted in a positive coefficient for the public deficit variable as has been assumed. But when the equation was estimated by TSLS to account for simultaneity the coefficient of public deficit shrank to a low value of 0.03 and its t statistic value to 0.13. The use of the first differences in public deficit did not fare any better. It was not possible to establish an influence of public deficit on construction investment.

On the other hand, the use of the current level of GNP instead of its changes in some of the construction and equipment investment functions, or the simultaneous inclusionof both, did not give any satisfactory results. The coefficient of the level of GNP was either negative or, when positive, most of the time it had large standard errors and consequently was insigificant.

5.7 Influences of Inflation and Capacity

Inflation can have serious consequences for investment and thus on productivity and future growth of the economy. It influences the real value of variables, which have a strong impact on investment. In particular an increase in inflation will affect the interest rate and thus the cost of funds. The real value of depreciation will be also changed during a period of rapid inflation, as it is based on the historical cost of assets.

In order to calculate the taxable profits, firms are allowed to subtract the cost of investment; as this is based on historical costs, the result is an increase in the tax rate on firms income, with adverse effects on profits and therefore on firms ability to finance investment.

By their nature, investment goods have long term repercussions for the firms, as they determine their future output, revenues and costs. To arrive at investment decision firms are influenced from their long term expectations, concerning future demand for their output, and future interest rates, prices and taxes. Inflation complicates these calculations even further, as expectation about long term inflation should be also taken into consideration.

In this section an attempt will be made to capture some of these effects by approximating the complex influence of inflation on investment with a simple linear relation, in which the current level of inflation is included in investment functions. As a measure for current inflation, the rate of change of the implicit deflator of each investment category has been employed. In addition, in housing investment the rate of change of consumers price has been also used.

The inclusion of the inflation rate variable (measured as $\frac{PCI_t - PCI_{t-1}}{PCI_{t-1}}$), in construction investment has not exerted any impact. The coefficient of this variable was insignificant, with a large standard error. This cannot rule out the influence of inflation on construction investment. Rather it is indicative of the fact that for this long-lived type of investment, the measure used to account for inflation does not properly reflect its influence.

On the other hand, for equipment investment the effect of inflation measured as $\frac{PEI_t - PEI_{t-1}}{PEI_{t-1}}$ has been found to exercise a mild impact on investment behaviour, as the following results indicate:

5.7.1 $$EI_t = \underset{(0.43)}{328.31} + \underset{(2.16)}{0.133}\Delta Q_t + \underset{(1.65)}{0.054}\frac{LO}{PEI} + \underset{(3.98)}{0.77}\,EI_{t-1} - \underset{(1.66)}{141.88}\,\frac{PEI_t - PEI_{t-1}}{PEI_{t-1}}$$

$R^2 = 0.98$ $\bar{R}^2 = 0.977$ SEE = 1544.03 DW = 2.36 INC

The coefficient of inflation, although statistically insigificant, has a t statistic of 1.66. At the same time, the standard error of estimate is lower than that of the same equation, excluding inflation. As the value of the Durbin-Watson statistic falls into the inconclusive region, the equation was re-estimated for a first order autocorrelation correction with the following results:

5.7.2 $$EI = \underset{(0.19)}{125.37} + \underset{(2.75)}{0.162}\,\Delta Q_t + \underset{(1.17)}{0.034}\,\frac{LO}{PEI} + \underset{(5.32)}{0.815}\,EI_{t-1} - \underset{(1.88)}{146.86}\,\frac{PEI_t - PEI_{t-1}}{PEI_{t-1}}$$

$$p = \underset{(1.50)}{-0.305} \quad R^2 = 0.989 \quad \bar{R}^2 = 0.986 \quad SEE = 1517.16 \quad DW = 2.17\text{N.A.}$$

The results show an improvement in the standard errors of the coefficients, and inflation is statistically significant in one tail test. Only the coefficient of loans is statistically insignificant but its t statistic exceeds one. Moreover, in the equation (5.5.16) - without inflation - the t statistic was less than one. When this equation was estimated by TSLS, the coefficients had values almost similar to those estimated by OLS, with the exception of the inflation coefficient, which increased considerably. The standard error of the regression also increased considerably, to the figure 1869.4. The standard errors of individual coefficients were also increased, resulting in a statistically insignificant coefficient for changes in output ($t = 1.26$). So it was decided that equation (5.7.2) should be preferred, although it probably underestimates the effects of inflation. Tested for forecasting accuracy, this equation performed better than all previous ones. The $Z_{1(3)}$ statistic dropped to 4.030 and the sum of forecast errors fell to 5.2 billion drs.

The dropping of loans from the equation (5.7.2) resulted in deterioration of its statistical properties, and its forecasting accuracy. On the other hand, when the interest rate was included, these properties remained inferior to those of equation (5.7.2), while the value of t statistic for interest rate was less than one.

PHI_t is the implicit deflator for housing investment. The alternative measures for inflation rate did not have any significant impact on housing investment. The first one, based on the implicit deflator for housing investment $\frac{PHI_t - PHI_{t-1}}{PHI_{t-1}}$ was included in (5.5.14) and was found totally insignificant (t = 0.49) when estimated by OLS; it just equalled its standard error when the equation was corrected for autocorrelation. The second, based on the rate of change of consumers price index (CPI) was also statistically insignificant. The values of the t statistic in this case were 1.14, when estimated by OLS, and 1.43 when the equation was corrected for autocorrelation, as can be seen from the results below:

5.7.3

$$HI_t = \underset{(1.72)}{1107.58} + \underset{(4.89)}{0.204\Delta DY} + \underset{(5.01)}{0.077}\frac{LO}{PHI} + \underset{(6.00)}{0.511}\, HI_{t-1} - \underset{(1.43)}{119.47}\ \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \qquad \underset{(2.36)}{p = 0.45}$$

$$R^2 = 0.98 \quad \bar{R}^2 = 0.976 \quad SEE = 1580.46 \quad DW = 2.39 \text{ INC}$$

The results suggest that the rate of change of consumer price index may have a weak influence on housing investment. Despite the correction of autocorrelation, the value Durbin-Watson statistics of equation (5.7.3) falls in the inconclusive region and suggests that autocorrelation may still exist in the residuals.

As the rest of the summary statistics between equations (5.7.3) and (5.5.13) are also similar, the latter equation was preferred for explaining investment in housing.

5.8 Capacity

It has already been mentioned that changes in output have a strong influence on investment. The existence of excess capacity permits firms to adjust to these changes gradually[(20)]. An initial change in output can be met, at least partially, by changing the utilization of their existing capital stock. Firms take current and past changes in output as an indication for future demand for their products. As the effects of investment last for a long period, the accompanying risks are great. If firms perceive that an increase in the demand for their product will persist, they may expand their capacity with new investment. That is, an increase in the rate of utilization will have a positive effect on investment. A number of empirical measures of capacity utilization have been proposed, none of them fully satisfactory.[(21)]

In an attempt to measure the effects of capacity utilization on investment, two such measures have been constructed and employed in the present study. Because of data limitations, no attempt to construct refined measures for this variable has been made.

The first measure is broadly based on the Wharton method[(22)]. To use this method first the output data of different industries have to be plotted, so that peaks in the series are identified. It is assumed that the peak output represents a 100 percent utilization of the resources of the economy. Straight lines are drawn between the peaks and the last one is extrapolated. The slope of this last straight line is assumed to prevail after the last peak. These lines represent the capacity output. Capacity utilization, then, is the ratio of actual output to the corresponding points on these lines. Then the aggregate capacity utilization rate is constructed as a weighted average of the ratios of different industries; the added value, corresponding to these peaks, is used as weights.

In employing this procedure, real GNP was used as the output series. As GNP was increasing in all the sample years except one (1974) the identification of peaks was difficult. It was thus decided to plot both output and its first differences and to use the peaks of first differences as output peaks. In this way five peaks were identified, corresponding to the years 1956, 1961, 1965, 1969 and 1973. To represent capacity GNP straight lines were fitted between the peaks. The slope of the first line between 1956-61 was assumed to prevail for the two previous years; the slope of the line between 1969-73 has been used for the years 1974-77. GNP was then divided by contemporaneous figures on these lines, and figures representing capacity utilization were derived.

The second approach was to estimate a log linear time trend for GNP and to use the ratio actual output over the trend output as a crude measure of capacity utilization.

The following function has been estimated for the time trend of real GNP

$Y_t = ae^{bT}u$ where Y_t is the real GNP, T stands for time trend and u is the error term, assuming that it is normally distributed.

This function in its logarithmic form was estimated by OLS

$\log Y_t = \log a + bT + \log u$

and gave the following results

$Y_t = 88561.012\ e^{0.063068T}$ with standard error of estimate 0.03433.

Alternatively, both these measures were included linearly in the construction and equipment investment categories, in conjunction with other variables.

The main effect of including these capacity utilization measures in construction and equipment was to pick some of the effects of output changes with the result to render this coefficient statistically insignificant and sometimes negative. At the same time, the coefficient of capacity utilization measures were also insignificant.

5.9 The Lag Structure of Investment

Different lag structures have been used to represent the time process of investment, such as finite, rational and geometric distributed lags[(23)]. The general conclusion is that the distributed lag function has a smooth shape with weights increasing at the beginning and, after reaching a peak, starting to decline. The mean lag is about two years.

At the same time the weights of the geometric distribution have a declining pattern. The geometrically declining lag form has the advantage to be easily estimated. By suitable transofmraton to eliminate variables (Koyck transformation) only one more parameter has to be taken into account. At the same time, it imposes to these data a specific form of lag. This form may arise from expectation and partial adjustment models.

Mean lags, estimated from geometrically declining lags, are usually higher than those estimated from other lag distribution[(24)]. The differences between geometric and other lags have been attributed to the restrictive form of the former. Application of a geometric lag, when less restrictive forms are suitable, results in a specification error; the effect of omitting relevant variables is to cause an increase in the mean lag[25].

The flexible stock adjustment model belongs to the lag distribution with geometrically declining weights, as equation (5.3.3) shows. The equations have been estimated not only by least squares, but also with a first order autocorrelation scheme.

The finally accepted equations, which explain the investment behaviour in a satisfactory way, are (5.5.3) for construction, (5.7.2) for equipment and (5.5.13) for housing investment. They have mean lags of 5.02, 4.40 and 0.89 years respectively. In the light of what has already been said, the mean lags for construction and equipment investment seems to be long and biased upwards for an economy that has shown, for an almost uninterrupted period of time, a substantial rate of growth. Moreover a range of measures has been also taken to stimulate and increase investment.

As an alternative procedure and in order to examine the lag structure of the investment functions for various specifications the more general procedure of Almon polynomial distributed lag was employed. Because of the limitations of the data, low order polynomials of second and third degree were fitted, with a length of four to six years. In some specifications end point zero restrictions were imposed; their effect on the lag structure has been considered, even though there are indications that these end restrictions cause considerable bias in the estimates. Of the various specifications estimated by the Almon's technique a sample is represented below. Figures in brackets below the coefficients are absolute t values, except for those of mean lag (ML) and the sum of the distributed lag coefficients, which are their standard errors.

Construction Investment

1) $CI_t = \underset{(0.95)}{6629.69} + \underset{(6.06)}{0.106}\,\frac{LO}{PCI} + \underset{(1.77)}{169.5}\,\frac{PCI}{PGNPM}\,t - \underset{(3.49)}{2204.3}\Delta R_t + \sum_{i=0}^{4} a_i \Delta Q_t$ second degree

α_i
0.067 (1.06)
0.121 (3.09)
0.132 (4.33)
0.100 (4.85)
0.024 (1.08)

$\bar{R}^2 = 0.98$ SEE = 1047.1 DW = 1.95N.A.

$\Sigma a_i = \underset{(0.112)}{0.444}$ ML = $\underset{(0.48)}{1.76}$

2) $CI_t = \underset{(1.63)}{3598.14} + \underset{(3.47)}{0.058}\,\frac{LO}{PCI} + \sum_{i=o}^{5} a_i \Delta Q_t + \sum_{i=o}^{5} \omega_i \Delta R_t$

$\bar{R}^2 = 0.967$

SEE = 1277.9

DW = 1.44 INC.

second degree for ΔQ_t

and third degree for R_t

a_i	ω_i
0.227 (4.38)	-311.2 (0.43)
0.233 (6.94)	-816.2 (1.55)
0.214 (5.31)	-634.9 (1.25)
0.172 (3.88)	-196.0 (0.41)
0.105 (2.23)	+ 71.31 (0.14)
0.015 (0.21)	-261.8 (0.46)

$\Sigma a_i = \underset{(0.20)}{0.968}$ $\Sigma \omega_i = \underset{(2595.6)}{-2148.79}$

ML = $\underset{(0.47)}{1.73}$ ML = $\underset{(3.07)}{1.72}$

3) $CI_t = \underset{(1.59)}{2752.01} + \underset{(6.69)}{0.092}\,\frac{LO}{PCI} + \sum_{i=o}^{4} a_i \Delta Q_t + \sum_{i=o}^{4} \omega_i \Delta R_t$

$\bar{R}^2 = 0.959$

SEE = 1524.5

DW = 1.33 INC

Second degree for ΔQ_t

third degree for ΔR_t and for

both zero end restrictions

a_i	ω_i
0.210 (3.71)	-496.05 (0.65)
0.189 (5.38)	-804.9 (1.61)
0.157 (3.80)	-999.1 (2.33)
0.114 (2.66)	-989.5 (3.25)
0.062 (2.07)	-686.3 (2.68)

$\Sigma a_i = \underset{(0.14)}{0.734}$ $\Sigma \omega_i = \underset{(1845.3)}{-3976.3}$

ML = $\underset{(0.28)}{1.49}$ ML = $\underset{(0.70)}{2.14}$

4) $CI_t = \underset{(2.43)}{4182.07} - \underset{(0.41)}{444.36}\Delta R_t + \sum_{i=o}^{5} a_i \Delta Q_t$ Second degree polynomial

$\bar{R}^2 = 0.91$

SEE = 2079.4

DW = 0.94 INC

0.337 (5.29)
0.353 (11.22)
0.327 (7.46)
0.258 (5.47)
0.145 (4.72)
-0.010 (0.36)

$\Sigma a_i = \underset{(0.12)}{1.41}$ ML = $\underset{(0.19)}{1.63}$

5) $CI_t = \underset{(1.22)}{-6726.8} + \sum_{i=o}^{5} a_i \Delta Q_t + \sum_{i=0}^{4} \omega_i R_t$ Second degree for ΔQ_t ar third degree for R_t

$\bar{R}^2 = 0.94$

SEE = 1684.04

DW = 1.59 INC

0.374 (5.90)	682.2 (0.81)
0.348 (11.57)	283.3 (0.32)
0.292 (6.61)	308.7 (0.71)
0.206 (4.12)	346.6 (0.48)
0.091 (2.46)	-14.83 (0.01)
-0.054 (2.01)	

$\Sigma a_i = \underset{(0.14)}{1.25}$ $\Sigma\omega_i = \underset{(679.5)}{1605.9}$

ML = $\underset{(0.26)}{1.30}$ ML = $\underset{(1.32)}{1.17}$

Equipment Investment

6) $EI_t = \underset{(2.50)}{17273.6} + \underset{(9.23)}{0.145} \frac{LO}{PEI}_t - \underset{(2.66)}{150.8} \frac{PEI}{PGNPM}_t - \underset{(0.69)}{377.7} R_t +$

$\sum_{i=o}^{4} a_i \Delta Q_t$ Second degree

0.110 (2.06)
0.159 (4.55)
0.157 (6.09)
0.104 (5.73)
0.0004 (0.01)

$\bar{R}^2 = 0.99$

SEE = 934.9

DW = 2.42 INC

$\Sigma a_i = \underset{(0.09)}{0.532}$ ML = $\underset{(0.30)}{1.48}$

7) $$EI_t = \underset{(2.50)}{14438.6} + \underset{(15.95)}{0.123} \frac{LO}{PEI}_t - \underset{(2.74)}{151.5} \frac{PEI}{PGNPM}_t + \sum_{i=o}^{5} a_i \Delta Q_t$$

Second degree

0.160 (5.60)
0.174 (9.00)
0.164 (7.66)
0.131 (6.06)
0.074 (4.68)
-0.006 (0.50)

$\Sigma a_i = 0.698$ (0.08)

ML = 1.66 (0.15)

$\bar{R}^2 = 0.99$

SEE = 898.8

DW = 2.45 INC

8) $$EI_t = \underset{(2.59)}{14621.0} + \underset{(15.78)}{0.126} \frac{LO}{PEI}_t - \underset{(2.82)}{152.4} \frac{PEI}{PGNPM}_t + \sum_{i=o}^{5} a_i \Delta Q_t$$

Third degree

$\bar{R}^2 = 0.99$

SEE = 877.3

DW = 2.44 INC

$\Sigma a_i = 0.66$ (0.09)

ML = 1.56 (0.17)

0.142 (4.57)
0.191 (8.32)
0.172 (7.91)
0.114 (4.52)
0.045 (1.66)
-0.0049 (0.44)

9) $$EI_t = \underset{(0.75)}{7032.6} + \underset{(14.52)}{0.153} \frac{LO}{PGI}_t - \underset{(0.77)}{70.9} \frac{PEI}{PGNPM}_t + \sum_{i=o}^{3} a_i \Delta Q_t$$

$\bar{R}^2 = 0.96$

SEE = 1790.22

DW = 1.22 INC

$\Sigma a_i = 0.347$ (0.10)

ML = 0.708 (0.619)

0.179 (3.24)
0.104 (3.41)
0.049 (1.88)
0.014 (0.72)

Second degree and zero end restrictions

10) $$EI_t = \underset{(0.98)}{-728.9} + \underset{(13.11)}{0.137} \frac{LO}{PEI}_t - \underset{(1.19)}{84.29} \frac{PEI_t - PEI_{t-1}}{PEI_{t-1}} +$$

$\Sigma a_i \Delta Q_t$ Second degree

0.104 (2.40)
0.169 (7.00)
0.174 (6.70)
0.119 (5.73)
0.003 (0.25)

$\Sigma a_i = 0.57$ (0.08)

ML = 1.55 (0.16)

$\bar{R}^2 = 0.98$

SEE = 1083.6

DW = 2.38 INC

Housing Investment

11)

$$HI_t = \underset{(0.66)}{6828.44} + \underset{(4.15)}{0.105}\,\frac{LO}{PHI} - \underset{(0.45)}{60.5}\,\frac{PHI}{CPI} + \sum_{i=o}^{3} a_i \Delta DY_t$$

$\Sigma a_i = 0.427$ (0.06)

$\bar{R}^2 = 0.95$

SEE = 1595.26

ML = 0.66 (0.06)

DW = 2.21 INC

0.214 (6.89)
0.142 (5.86)
0.071 (2.98)
-0.0007 (0.03)

Second degree

12)

$$HI_t = \underset{(0.07)}{624.5} + \underset{(3.90)}{0.087}\,\frac{LO}{PHI} + \underset{(0.11)}{13.22}\,\frac{PHI}{CPI} + \sum_{i=o}^{4} a_i \Delta DY_t$$ Second degree

$\Sigma a_i = 0.508$ (0.08)

ML = 0.99 (0.15)

$\bar{R}^2 = 0.95$

SEE = 1579.19

DW = 2.46 INC

0.232 (7.89)
0.138 (6.65)
0.073 (3.19)
0.036 (1.80)
0.027 (1.14)

13)

$$HI_t = \underset{(1.67)}{1656.57} + \underset{(11.97)}{0.089}\,\frac{LO}{PHI} + \Sigma a_i \Delta DY_t$$ Second degree

$\bar{R}^2 = 0.95$

SEE = 1526.38

DW = 2.45 INC

0.231 (8.44)
0.138 (6.88)
0.073 (3.35)
0.036 (1.88)
0.026 (1.18)

$\Sigma a_i = 0.507$ (0.08)

ML = 0.99 (0.15)

14) $$HI_t = \underset{(0.43)}{19968.7} + \underset{(1.30)}{0.136}\frac{LO}{PHI} + \sum_{i=o}^{5} a_i \, \Delta DY_t + \sum_{i=o}^{5} \omega_i \, \frac{PHI}{CPI}_t$$

Third degree for both ΔDY_t and $\frac{PHI}{CPI}_t$

$\bar{R}^2 = 0.92$

SEE = 1905.86

DW = 2.31

a_i	ω_i
0.220 (2.56)	194.6 (0.63)
0.102 (1.14)	147.1 (0.47)
0.017 (0.23)	5.53 (0.01)
-0.029 (0.34)	-151.6 (0.61)
-0.037 (0.45)	-246.1 (0.83)
-0.004 (0.10)	-199.5 (0.60)
Σa_i = 0.27 (0.31)	$\Sigma\omega_i$ = -249.6 (599.5)
ML = -0.44 (2.14)	ML = 9.11 (11.33)

15) $$HI_t = \underset{(0.63)}{19690.7} + \underset{(1.76)}{0.131}\frac{LO}{PHI} + \sum_{i=o}^{4} a_i \Delta DY_t + \sum_{i=o}^{4} \omega_i \frac{PHI}{CPI}_t$$

Second degree for ΔDY_t and third for $\frac{PHI}{CPI}$

$\bar{R}^2 = 0.94$

SEE = 1713.7

DW = 2.47

a_i	ω_i
0.208 (3.29)	195.2 (0.83)
0.100 (1.91)	-3.61 (0.01)
0.033 (0.58)	-69.3 (0.45)
0.006 (0.16)	-141.1 (0.53)
0.021 (0.75)	-250.6 (0.92)
Σa_i = 0.369 (0.18)	$\Sigma\omega_i$ = -241.9 (40.8)
ML = 0.73 (0.65)	ML = 6.14 (6.82)

16) $$HI_t = \underset{(0.31)}{9052.05} + \underset{(1.54)}{0.108}\frac{LO}{PHI} \Sigma a_i \Delta DY_t + \Sigma\omega_i \frac{PHI}{CPI}_t$$

Second degree for ΔDY_t and third degree for $\frac{PHI}{CPI}_t$ for both zero and restrictions imposed

$\bar{R}^2 = 0.94$

SEE = 1678.5

DW = 2.27

a_i	ω_i
0.211 (3.93)	-26.2 (0.18)
0.137 (3.35)	-38.9 (0.27)
0.079 (2.74)	-27.8 (0.19)
0.037 (1.15)	-7.9 (0.05)
0.010 (0.52)	6.28 (0.04)
Σa_i = 0.477 (0.16)	$\Sigma\omega_i$ = -94.6 (377.8)
ML = 0.94 (0.30)	ML = 0.98 (12.28)

It should be noted that the above equations have been estimated without autocorrelation correction and in some of them the effects would be serious as the value of the Durbin-Watson statistic indicates. The results obtained by the estimation of polynomial distributed lags give a picture of the length of mean lag different from that arising from the estimation of the stock adjustment model, with the exception of housing investment. The results from the use of the Almon technique point to the following conclusion: In construction and equipment investment, depending on the exact specification, the mean lag is always less than two years, ranging from 1 to 1.8 years for the former and 1 to 1.6 years for the latter. Changes in output were found to have a statistically significant effect on both investment categories, going back to around four years. The coefficients follow a smooth shape and reach a peak after one or two lags before they start declining. When zero end restrictions were imposed, the coefficients followed a monotonically decreasing pattern. Lags on other variables had wrong signs and were statistically insignificant.

These results cast serious doubts about the length of mean lag derived from the estimation of the flexible stock adjustment model for the two investment categories. The mean lag derived from the stock adjustment model was in excess of 3 years, sometimes extending over 10 years. This clearly indicates that this model has biased upwards the estimate of mean lag, by imposing this restrictive form of geometrically declining weights.[26] On the other hand, the estimates of mean lag for housing investment, whether estimated by polynomial distributed lags or derived from the stock adjustment model, largely coincide, ranging from half to one year.

When the Almon procedure was used, changes in disposable income were found to have a statistically significant effect on housing investment. They spread back to two or three years, with a monotonically declining pattern, a feature shared by the estimates derived from the stock adjustment model. Lags for other variables included in housing investment had invariably wrong signs and were statistically insignificant.

5.10 Inventory Investment

The significance of inventories for an economy arises primarily not from their size but from their short run effects on economic activity. Demand for inventories is strongly sensitive to economic fluctuations on which they exert an important influence. Hence the significant role that inventories play in determining the short run business cycle.

Firm motives to hold inventories are usually classified into the three categories of transactions, precaution and speculation.

The first motive arises from such factors as lags between production and delivery of goods or lags between the time goods and materials have been acquired and the time they have been used in the production process or sold; stocks will be also needed by firms for display, advertisements and similar purposes.

Precautionary motive is concerned with the importance of holding inventories, so that the firm should be protected from fluctuations in demand, expected or unforeseen. At the same time, the supply of goods may be also uncertain. The existence of inventory stocks secures an undisturbed and smooth flow of production to meet demand. On the other hand, it protects firms from losses caused by inability to meet sudden increases in demand.

The third motive, that of speculation, is associated with the profit opportunities, arising when the expected price changes of the goods held exceed the ruling prices. Such expectations will lead to inventory changes.

The size of the inventory stocks is limited by the costs on the firms for holding them, e.g. opportunity costs, overheads and direct costs of storage and display. Other factors effecting the costs are changes in taxes and interest rates, as well as changes in consumers' tastes which may render some goods obsolete.

Stock adjustment models based on the acceleration principle have been extensively used in empirical works, in order to explain changes in inventory investment(27). The following analysis is conducted in the framework of the stock adjusted model.

The desired level of inventories investment is assumed to depend linearly on changes in final expenditure (ΔFE) in equation (5.3.1). After substituting into equation (5.3.2), we get equation

5.10.1 $$II_t = a_o b + a_1 b \Delta FE_t + (1-b) II_{t-1}$$

When firms expect prices to increase in the immediate future, they will try to be protected from higher costs by increasing the stocks they hold. When significant increases of prices are expected, speculation motives may also lead to changes in stocks held. A high inflation rate may delay or reduce consumers' purchases, leading to changes in stock larger than those planned by the firms.

To account for the complex effects arising from price changes on inventories the rate of change of consumer price index (CPI) has been included in the above equation, as a proxy for them, and a positive association is expected.

Finally, the estimated equation for changes in stock has the form

$$5.10.2 \qquad II_t = a_o b + a_1 b \Delta FE_t + a_2 b \frac{CPI_t - CPI_{t-1}}{CP_{t-1}} + (1-b) II_{t-1}$$

When the equation was estimated by ordinary least squares, it gave the following result

$$5.10.3 \qquad II_t = \underset{(1.84)}{-1732.91} + \underset{(4.80)}{0.176} \Delta FE_t + \underset{(6.20)}{701.5} \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} + \underset{(3.37)}{0.342}\, II_{t-1}$$

$$R^2 = 0.91 \quad \bar{R}^2 = 0.90 \quad SEE = 2445.89 \quad DW = 2.20 \text{ N.A.}$$

The coefficients have the expected signs (as explained above) and are statistically significant. The Durbin-Watson statistics indicate the absence of autocorrelation, which was confirmed when the autocorrelation correction was applied. The magnitude of autocorrelation coefficient is small (p = 0.165) and statistically insignificant, with a t value less than one (0.78).

The results of testing the equation for forecasting accuracy were also satisfactory. The $Z_{1(3)}$ test has a very low value 1.118, while the critical value is 7.815. The sum of forecasting errors for the period 1978-1980 is 4 billion drs.

Some modifications of the above equation were also tested. The level of final expenditure (FE), added in equation (5.10.3) does not have any significant impact on the coefficients.

5.10.4 $$II_t = \underset{(1.19)}{-222.5} + \underset{(0.30)}{0.0039FE} + \underset{(2.54)}{0.1609\Delta FE_t} + \underset{(5.37)}{685.05}\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} + \underset{(1.72)}{0.299\,II_{t-1}}$$

$R^2 = 0.91$ $\bar{R}^2 = 0.89$ SEE = 2506.3 DW = 2.20 N.A.

The corrected R^2 and the standard error of estimate are slightly worse than those of equation (5.10.3), while the value of the t statistic coefficient for final expenditure is very low (0.30). The $Z_{1(3)}$ is slightly higher (1.689) and the sum of forecasting error for the three years reached 5.3 billiondrs.

Replacing the variable FE_t in equation (5.10.3) by the level of final expenditure (FE) led to further deterioration in the results:

5.10.5 $$II_t = \underset{(2.41)}{-4486.39} + \underset{(3.47)}{0.029FE_t} + \underset{(4.19)}{559.9}\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} + \underset{(0.18)}{0.029II_{t-1}}$$

$R^2 = 0.88$ $\bar{R}^2 = 0.86$ SEE = 2844.6 DW = 2.27 N.A.

The value of $Z_{1(3)}$ statistic (9.074), larger than the critical one (7.815), points against this specification.

Some other specifications were also estimated and a sample of the results is given below:

$$II_t = -5402.5 + \underset{(3.24)}{0.032FE_t} + \underset{(1.58)}{0.304II_{t-1}}$$
$$ (2.16)$$

$R^2 = 0.77$ $\bar{R}^2 = 0.75$ SEE = 3846.4 DW = 1.74 N.A.

$$II_t = \underset{(1.78)}{-5018.4} + \underset{(1.79)}{0.0325FE_t} + \underset{(0.32)}{0.03\Delta FE_t} + \underset{(1.34)}{0.36II_{t-1}}$$

$R^2 = 0.78$ $\bar{R}^2 = 0.74$ SEE = 3935.2 DW = 1.73 N.A.

$$II_t = \underset{(2.10)}{-6230.3} + \underset{(2.46)}{0.059Q_t} - \underset{(0.52)}{0.087\Delta Q_t} + \underset{(0.98)}{0.245II_{t-1}}$$

$R^2 = 0.77$ $\bar{R}^2 = 0.73$ SEE = 4021.06 DW = 1.80 N.A.

$$II_t = \underset{(1.75)}{-5880.09} + \underset{(1.70)}{0.079}\,(CND + CD)_t + \underset{(0.53)}{0.164}\,\Delta(CND + CD)_t + \underset{(1.61)}{0.379\,II_{t-1}}$$

$R^2 = 0.76$ $\bar{R}^2 = 0.72$ SEE = 4061.6 DW = 1.70 N.A.

In all cases the summary statistics ($\bar{R}^2$, SEE) were inferior to those of equation (5.10.3). Coefficients had often had magnitudes less than their standard error and the forecasts which they generated outside the sample period were invariably worse.

Recapitulation

We may conclude that stock adjustment principle is a valuable analytical model for the examination of investment behaviour. Although the critical role of changes in GNP has been demonstrated (see the preferred equations below), other important factors also contribute to the explanation of investment behaviour (changing the symbols of the variables Q to GNP, R to RL - i.e. the interest rate to long term credits to industry - and LO to LOAN).

5.5.7 $$CI_t = \underset{(1.51)}{3303.3} + \underset{(4.36)}{0.258\Delta GNP_t} - \underset{(1.19)}{289.12 RL_t} + \underset{(19.54)}{0.834 CI_{t-1}}$$

SEE = 1434.54 DW = 2.05 N.A. $Z_{1(3)} = 4.339$

estimated by 2SLS

5.7.2 $$EI_t = \underset{(0.19)}{125.37} + \underset{(2.75)}{0.162\Delta GNP_t} + 0.034 \frac{LOAN}{PEI}t - \underset{(1.88)}{146.86} \frac{PEI_t - PEI_{t-1}}{PEI_{t-1}} + \underset{(5.32)}{0.815\, EI_{t-1}}$$

$p = \underset{(1.50)}{-0.305}$ $R^2 = 0.98$ $\bar{R}^2 = 0.98$ SEE = 1517.16

DW = 2.17 N.A. $Z_{1(3)} = 4.030$ estimated by GLS

5.5.17 $$HI_t = \underset{(2.03)}{1277.59} + \underset{(9.13)}{0.251\,\Delta DY_t} + \underset{(4.80)}{0.049 \frac{LOAN}{PHI}t} + \underset{(5.89)}{0.471\, HI_{t-1}}$$

$p = \underset{(2.65)}{-0.492}$ $R^2 = 0.97$ $\bar{R}^2 = 0.97$ SEE = 1624.48

DW = 2.36 N.A. $Z_{1(2)} = 20.638$ estimated by GLS

5.10.3 $$II_t = \underset{(1.84)}{-1732.91} + \underset{(4.80)}{0.176\Delta FE_t} + \underset{(6.20)}{701.5} \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} + \underset{(3.37)}{0.342\, II_{t-1}}$$

$R^2 = 0.91$ $\bar{R}^2 = 0.90$ SEE = 2445.8 DW = 2.20 N.A.

$Z_{1(3)} = 1.118$ estimated by OLS

Various financial considerations have a role to play in determining investment. The interest rate was found to play a mild role in constructions, while credits have a similar effect on equipment investment and a strong one on housing. At the same time a significant influence of inflation on equipment investment has been established, and its influence on inventories is pronounced.

The mean lags for construction and equipment investment are rather biased upwards, as the use of Almon's technique of distributed polynomial lags has indicated. On the other hand, the forecasting accuracy of the above equations, except for that of housing, is satisfactory, as the values of Z_1 statistic show. For housing investment the high value of Z_1 statistic casts doubts on this specification. To the same conclusion point both the statistically significant autocorrelation found on the residuals and indicating the omission of certain influential factors, and the need for a more detailed and comprehensive model of the housing market. These results are also reflected in the figures for RMSE and RMSPE given in the table below. While these figures could be regarded as satisfactory for construction inventory and especially equipment investment, the RMSPE for housing investment has a considerably large value of around 14 percent.

Variables	RMSE in billion drs.	RMSPE %
CI	1.7	6.25
EI	1.8	4.79
HI	4.3	13.95
II	1.5	7.81

FOOTNOTES TO CHAPTER 5

1. The figures in all tables are for gross fixed investment, that is capital consumption is also included.

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6. EMPLOYMENT - TAXES AND OTHER ESTIMATED FUNCTIONS

6.1 Employment

Most studies pertaining to explain the demand for employment are based on the neoclassical production theory.

It is assumed that there exists an optimal labour input, which consists of the number of persons employed and the number of worked hours per person. It is recognised that, because of the wage costs and of adjustment costs associated with changes in employment (as training costs, overtime, lay off costs), firms do not adjust immediately their actual labour input to its optimal level.

Furthermore, it is also assumed that in the short run the capital services input is fixed, but firms can vary the utilization rate of the capital stock.

Basically, a short-run production function is postulated, where the output produced in each period is related to labour services, the capital stock and the existing state of technology. By assuming either cost minimizing or profit maximizing behaviour of firms, the function for the demand of labour is derived(1).

In the case of cost minimization, a Cobb-Douglas production function is usually assumed, of the form:

6.1.1 $$Q_t = A(E_t H_t)^a e^{\gamma t}$$ where

Q_t is output, E_t the number of persons employed, H_t hours worked per employee and $e^{\gamma t}$ the time trend to capture the effects of technical progress, under the assumption that it grows smoothly over time at a rate γ(2). The effect of capital is also assumed to be exercised through the constant term. The elasticity of output with respect to labour services is a; in the case of diminishing returns to labour in the short-run, a should be less than one.

The cost minimizing approach postulates a total cost function (TC) of the form:

6.1.2 $$TC = W_H E_t H_t + F_t$$

where F_t is the fixed costs of production during the period t related to the capital input assumed fixed in the short run, and W_H is the effective wage per man-hour, which can be approximated by a quadratic function in hours worked (H_t)(3) such as:

6.1.3 $$W_H = C_o - C_1 H_6 + C_2 H_t^2$$

Substituting for W_H in the cost equation (6.1.2) total cost is derived as:

6.1.4 $$TC = C_o E_t H_t - C_1 E_t H_t^2 + C_2 E_t H_t^3 + F_t$$

which is a function of the labour input $(E_t H_t)$ and fixed costs. Then the production function is solved for hours worked (H_t). The resulting expression is substituted in the equation (6.1.4), and total cost is expressed as a function of the production function variables:

6.1.5 $$TC = C_o \left[A^{-1/a} Q^{1/a} e^{-\frac{\gamma}{a}t}\right] - C_1 \left[A^{-1/a} Q^{1/a} e^{-\frac{\gamma}{a}t}\right]^2 E_t^{-1} + C_2 \left[A^{-1/a} Q^{1/a} e^{-\frac{\gamma}{a}t}\right]^3 E^{-2} + F_t$$

Minimizing the above function with respect to employment (E_t) - equating its first derivative to zero - the desired (optimal) employment function (E_t^d) is derived as:

6.1.6 $$E_t^d = \frac{2c_2}{c_1 A^{1/a}} Q^{1/a} e^{-\frac{\gamma}{a}t}$$

This function gives the optimal level of employment, optimal in the sense that this level minimizes costs with respect to production function and has as its arguments output and a time trend. That is:

6.1.7 $$E_t^d = f\ (Q,t)$$

In the case of profit maximization behaviour, it is assumed that firms will set the level of labour requirements so that profits will be maximized. Following Drymes[(4)], a constant elasticity of substitution production function is postulated with capital (K) and the number of workers (E_t) as its arguments:

6.1.8 $$Q_t = A\,[\,b_1 K^{\rho} + b_2 E^{\rho}]^{1/\rho}$$

with constant elasticity of substitution $\sigma = \frac{1}{1-\rho}$

He then assumes that optimal employment is determined by the marginal conditions.

6.1.9 $$\frac{\partial Q}{\partial E} = S_{(t)} W$$

where $S_{(t)}$ is a well defined function of the elasticity of demand for output and supply of labour and W is the real wage[5]. That is the desired level of employment by firms is that level at which the marginal product of labour equals the real wage rate. Solving (6.1.8) for the number of workers (E_t), the corresponding demand function for employment is derived:

6.1.10 $$E_t^d = A^*W^{1/(\rho-1)}Qb_2^{\,1/(1-\rho)} \quad \text{where } A^* = A^{\rho/(1-\rho)}(S_t)^{\rho/(\rho-1)}$$

Thus the demand for labour, in this case of profit maximizing behaviour, is a function of output and the wage rate. A time trend is added as well, to account for the effects of technological progress. So that the desired employment function is:

6.1.11 $$E_t^d = f(Q,W,t)$$

Critisizing these views, Fair has argued that, if an employment demand equation derived from a production function is used, the attempt to estimate the parameters of the short run production function, in the standard way, is bound to fail, because the true labour inputs are not observed. He has then distinguished between the observed number of hours paid for per worker and the (unobserved) number of hours actually worked. He argues that the latter equals the former only during peak output periods.

Contrary to previous studies, he assumed no substitution between workers and machines in the short run and constant returns to scale to both labour and capital inputs[6].

So the production function is specified as:

6.1.12 $Q_t = \min \{a_t E_t H_t, b_t K_t H_t\}$

where E, H and K have been previously defined and $\frac{1}{a}$ and $\frac{1}{b}$ are the labour output and capital output ratios which may change through time, as a result of technical progress. Under the further assumption that there are not idle workers or machines, which implies equality between $\alpha_t E_t H_t$ and $b_t K_t H_t$ in (6.1.12), the production function is:

6.1.13 $Q_t = a_t E_t H_t$ or $E_t H_t = \frac{1}{a_t} Q_t$

This relation gives the number of man-hours, actually required to produce any given output, as a function of output. Then, Fair defines the desired number of workers employed (E^d) as the number of workers required to generate a given level of man-hours ($E_t H_t$), if each worker works the standard (desired) number of hours (H_t^*). This gives $E_t^d H_t^* = E_t H_t$ and thus:

6.1.14 $E_t^d = \dfrac{E_t H_t}{H_t^*}$

So E_t^d is the optimal level of employment in the long run. That is, in the long run, hour costs will be minimized when workers work the standard (desired) number of hours(7). Substituting from (6.1.13) to (6.1.14) for $E_t H_t$, we get the employment function:

6.1.15 $E_t^d = \dfrac{1}{a_t} \dfrac{Q_t}{H_t^*}$

In all the discussed models it is further postulated that firms may not adjust their actual level of employment (E_t) to its optimal level (E_t^d) at once. That level is optimal in the long run and it is assumed that entrepreneurs adjust employment to the desired level with a lag. The reasons for this lagged adjustment concern expectations and costs. Firms face costs associated with the employment changes, and these costs may vary with the speed of adjustment.

On the other hand the uncertainty which characterises firms expectations concerning future output and wages may make them reluctant to fully adjust to the optimal level of employment. For these reasons, an adjustment function is also postulated, whether the demand for employment function is derived from cost minimization or profit maximization behaviour, and it usually takes the form of the partial adjustment process as:

6.1.16 $$E_t - E_{t-1} = \lambda(E_t^d - E_{t-1}) \qquad 0 \leq \lambda \geq 1$$

where λ is the adjustment coefficient. Substituting from equations (6.1.7) or (6.1.15) for the unobserved variable E_t^d the estimated short run demand function for employment is obtained.

The main cause of dissatisfaction with the demand for employment function, which casts doubts on these specifications, is the value of the elasticity of output with respect to employment. In nearly every study(8) the estimates for the elasticity of output with respect to employment are in excess of one, implying increasing returns to labour in the production function, thus violating the law of diminishing returns(9).

6.2 The model and the results

In the present study, because of the deficiency of employment data an attempt is made to estimate an aggregate employment function that can be used for forecasting purposes and not for testing hypotheses about short run demand for employment and the values of the coefficients of the implied production function.

It is postulated that desired employment is a function of output and the real wage

6.2.1 $$E_t^d = f(Q,W)$$

Because of the already mentioned factors which cause firms to adjust their actual to desired level of employment with a lag, a partial adjustment mechanism is also postulated.

6.2.2 $$\frac{E_t}{E_{t-1}} = \left(\frac{E_t^d}{E_{t-1}}\right)^{\lambda} \qquad 0 \leq \lambda \leq 1$$

Assuming a multiplicative form for the function (6.2.1), substituting it into (6.2.2) and taking logarithms for both sides, the estimated equation for employment is:

6.2.3 $$\ell nE_t = b_o + \lambda b1\ell nQ_t + \lambda b_2\ell nW_t + (1-\lambda)\ell nE_{t-1} + v_t$$

where E_t is the number (in thousands) of wage earners and salaried employees in industry and other activities (excluding agriculture).

Q_t, the output variable, is the GNP at factor cost in constant 1970 prices.

W_t, the real wage rate deflated by the consumer price index.

v_1 the random error term.

λ is the adjustment coefficient and bs the coefficients of the employment function (6.2.1) to be estimated.

As there are no data for the total number of wage earners and salaried employees in industry and other activities, the figures of the employment series were constructed in the following way. From the estimates of total employment in industry and other activities, given in the OECD labour force statistics (for the years 1956-1977), the rate of change between two successive years was calculated. Then starting from the number of wage earners and salaried employees in the industry and other activities, taken from the 1961 census, and using these calculated rates of change, the series of employment was constructed, under the assumption that, for both total employment and for the number of those employed as wage and salaried earners, the same rate of change holds.

This not very realistic assumption has certainly affected the quality of the employment data, reflected in the results below:

6.2.4 $$\ell nE_t = \underset{(1.22)}{0.4109} + \underset{(1.59)}{0.112}\ell nGNP_t - \underset{(0.69)}{0.0271}\ell nW_t + \underset{(6.08)}{0.794}\ell nE_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.90 N.A. SEE = 0.0105

Although the summary statistics are very satisfactory and the coefficients have the expected signs, the main explanatory variables that influence the desired level of employment (output and real wages), are statistically insignificant. The explanatory power of the equation is mainly the consequence of the lagged dependent variable, which has the already mentioned serious defects, by the way it has been constructed. As, according to the theory, output is the main factor in creating employment, it was decided to drop the lagged dependent variable from the analysis.

The time trend was included in the equation to account for long term factors, such as technical progress. As the growth of technological progress reduces the number of workers needed, a negative sign is expected. The inclusion of time trend produced results similar to those produced when the lagged dependent variable was used. That is, output has not any significant impact on employment. The positive sign of the time trend was opposite to the expected one, which would have picked the effects of technical progress. Thus, the time trend was also excluded from the estimated equation.

The equation for employment was estimated by including total output (GNP) and the real wage as explanatory variables with the following results:

$$\ell nE_t = \underset{(20.59)}{2.362} + \underset{(8.72)}{0.485}\ell nGNP_t - \underset{(1.84)}{0.104}\ell nW_t$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 0.98 POS. SEE = 0.0166

Because of positive autocorrelation in the residuals, indicated by the value of the Durbin-Watson statistic, the equation was re-estimated for a first order autocorrelation process ($v_t = \rho\, v_{t-1} + \varepsilon_t$).

Although the variables had the correct signs, the wage one was statistically insignificant (t value 0.10) and thus could not be kept in the equation:

$$\ell nE_t = \underset{(4.06)}{3.464} + \underset{(3.74)}{0.314}\ell nGNP_t - \underset{(0.10)}{0.0075}\ell nW_t \qquad \rho = \underset{(9.90)}{0.90}$$

$R^2 = 0.53$ $\bar{R}^2 = 0.48$ DW = 1.84 N.A. SEE = 0.0147

Because of the lack of data on capital stock, which could have been included in the employment function, the construction and equipment investment (CEI) was introduced as a proxy in the equation. The ordinary least squares estimates of the equation were:

$$\ell nE_t = \underset{(12.50)}{2.206} + \underset{(14.12)}{0.439}\ell nGNP_t - \underset{(1.85)}{0.0392}\ell nCEI_t$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 0.89 POS. SEE = 0.0166

While the results of the above equation, corrected for a first order autocorrelation, were:

6.2.5 $$\ell nE_t = \underset{(8.57)}{2.234} + \underset{(9.54)}{0.437}\ell nGNP_t - \underset{(1.13)}{0.0389}\ell nCEI_t \qquad \rho = \underset{(3.15)}{0.55}$$

$R^2 = 0.97$ $\bar{R}^2 = 0.96$ DW = 1.92 N.A. SEE = 0.0144

The above equation has the expected signs and satisfactory summary statistics. The output coefficient exceeds its standard error many times. The investment variable was retained in the equation on economic grounds (effect of growth of capital) and because its coefficient, although insignificant, exceeds its standard error.

The selected equation (6.2.5) has the defect already mentioned in the survey of the work as employment. That is, the magnitude of the output coefficient is small and thus the implied elasticity of output with respect to labour services exceeds one, in this case being about 2.30. Some efforts have been made to improve the results, by including the wage rate in the above function, and also by lagging the investment variable by one period. The results thus obtained were inferior, as were also those obtained by estimating a function with output as the only explanatory variable.

The equation (6.2.5) forecasts quite satisfactorily for the next two years (1978-1979), as the figures of the root mean square foreasting error and the root mean square percentage forecasting error indicate (43 thousand employees and 2.4% respectively). At the same time the value of the $Z_1(2)$ statistic was 5.575 inside the constant of the parameters outside the sample. Despite these results, the employment function should be considered with great caution because of the way the data for the employment variable have been constructed as mentioned previously.

6.3 Unemployment

To calculate the unemployment rate, which is the ratio of the unemployment to total labour force, a function for the latter is necessary. The figures for the unemployment are then derived by subtracting the number of employed from that of the total labour force.

Because of the already mentioned poor quality of the data used in estimating the employment function, and because the data for the labour force are also estimates (OECD Labour Statistics), it was decided to estimate an unemployment function for which data exist. In addition the specification of a labour force function would require an increase in the number of exogenous variables as demographic factors could have been included in the equation. Thus, the necessary series of the labour force is constructed by adding the figures of employment and unemployment. The purpose of the estimated unemployment function is to be used in forecasting and not in explaining the influence of factors affecting unemployment.

The following log-linear function is postulated:

6.3.1 $$\ell nUN_t = \alpha_o + \alpha n\ell nGNP_t + \alpha_2 T + \alpha_3 \ell nUN_{t-1} + u_t$$

where UN_t is the number of unemployed in thousands[10] and Q_t the output variable is real GNP at factor cost (1970 prices). As growth in output will lead to increased employment, a negative sign is expected for the output variable. T is the time trend, to account for long term demographic and other factors, and u_t is the random error term. The lagged dependent variable was also included to improve the fit of the equation, which was then estimated by ordinary least squares over the period 1957-1977.

It gave the following results:

6.3.2 $$\ell nUN_t = \underset{(2.47)}{37.169} - \underset{(2.30)}{2.992}\ell nGNP_t + \underset{(2.96)}{0.3808}\ell nUN_{t-1} + \underset{(1.76)}{0.142T}$$

$R^2 = 0.89$ $\bar{R}^2 = 0.87$ DW = 1.14 INC. SEE = 0.177

Because of the low value of the Durbin-Watson statistic, the equation was re-estimated for a first order autocorrelation. Although for the equation corrected for autocorrelation the Durbin-Watson statistic indicated the absence of autocorrelation in the residuals (DW = 1.56), the relevant coefficient (ρ) was statistically insignificant (t value 0.67), and thus the equation (6.3.2) was retained. Using this equation (6.3.2) forecasts were generated and compared with the actual figures for the two successive years (1978 and 1979) for which data exist[11]. The figures predicted by the equation, 29 and 31 thousands, are very close to the actual figures 31 and 32 thousands respectively. On these figures the root mean square percentage forecasting error is 5%, while the root mean square forecasting error is 1.4 thousands, while the value of the $Z_1(2)$ statistic is inside the critical value (actual value 0.223 and the critical one from the χ^2 tables with 2 degrees of freedom is 5.992).

6.4 Taxes and Subsidies

The revenues and expenditure of the general government (central and local) originate from both economic and non-economic factors. For example governments have to take measures for the national defence, to fulfill obligations for particular expenditure programs and to provide some essential services.

The main resource of government revenues are taxes which are basically determined by the tax rates, controlled by law, and the changes in such economic magnitudes as income and expenditure.

Government fiscal measures (for example altering tax rates for the different types of expenditure or changing their own expenditure), could have important effects on the economy. By using these policy instruments, governments try not only to satisfy different requirements but also to influence the course of the economy.

The large number of factors determining government policies and subsequently the size of its expenditure and revenues, the complexity of the tax system, the diversity of tax rates, present considerable difficulties which coupled with data limitations, preclude a detailed and more appropriate analysis of the government sector in a model such as the present one.

Government receipts and expenditure enter this model to determine the gross national product and the disposable income and to calculate the tariff rate used in the import functions.

The expenditure side is represented by two exogenous variables (the government current expenditure on goods and services, and its current net transfers to households) and by one endogenous variable (subsidies). For the revenue side the endogenous variables are: direct taxes, employers contributions to social insurance, duty taxes, and the rest of the indirect taxes. For the endogenous variables simple aggregate linear equations were estimated in value terms; the data used are those given in the country's national accounts.

Direct Taxes

In the direct taxes variable (DT) the income taxes collected by central government, local authorities, other public organizations and employees contribution to social insurance were included; the last item is relatively the largest in this tax category.

The rate of employers contributions to social insurance could be used as a policy instrument by governments, among other fiscal measures to influence the costs of production and the course of the economy. It was thus decided to exclude these contributions from the direct taxes variable and instead to estimate a separate function for them.

Direct taxes were linearly related to two variables accounting for the two main sources of income, wages and salaries (WYV) and non-wage income (NWYV)(12). The coefficient of the non-wage income, because of multicollinearity, was insignificant (the value of the t statistic was usually less than one and sometimes barely exceeds it) or negative, whether the current or lagged variable was included in the equation. When these equations were estimated by generalised least squares, autocorrelation proved to be a serious problem, as the relevant coefficient (ρ) was in the range of -0.80 to -0.90.

Finally, the change in non-wage income (its first differences) was included in the equation, which was then estimated through the origin and gave the following results:

6.4.1 $$DT = \underset{(24.74)}{0.228} WYV_t + \underset{(1.61)}{0.0716} [NWYV_t - NWYV_{t-1}]$$

$$DW = 2.09 \text{ N.A.} \qquad SEE = 2480.15$$

Although the coefficient of ΔNWYV is statistically insignificant, its t value still considerably exceeds one (the critical value for one tail test is 1.72) and so it was kept in the equation.

The employers contributions to social insurance (ECV) were related linearly to the wage and salary income (WIV). The equation was estimated by ordinary least squares. As the Durbin-Watson statistic showed positive autocorrelation in the residuals, the equation was re-estimated for a first order autocorrelation process with the following results:

6.4.2 $$ECV_t = -\underset{(4.34)}{931.869} + \underset{(74.01)}{0.1067}WIV_t \qquad \underset{(2.76)}{\rho = 0.50}$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 1.66 \text{ N.A.} \qquad SEE = 358.615$$

The time trend was found statistically insignificant. Similarly insignificant was the number of employed when included in the above equation. As there were no separate figures for the years 1978-1980, concerning the employers contributions to social insurance, it was not possible to test the forecasting performance of each equation. Instead, the forecasts which were generated by each equation for the three years (1978-1980) were added to derive the forecasts for total direct taxes. These forecasts were then compared with the actual figures for direct taxes. The forecasts are very close to the actual figures for the first two years, for which the cumulative forecasting absolute error is 2.7 billion drs, the root mean square forecasting error is 1.4 billion drs and the root mean square percentage forecasting error is less than one percent (0.9%). For the third year, however, the equations considerably underestimate total direct taxes by an amount of about 20 billion drs. Thus there is a significant increase in the corresponding figures of mean square forecasting errors to 11.5 billion drs and 4.7% respectively.

Indirect Taxes

Indirect taxes consist of import duties, taxes on sales of goods and services, on real estate transfers and stamp duties. This broad category of taxes was divided into two groups: Import duties (DUT), which were related to the value of total imports of goods, and the rest of indirect taxes (IT) which were related to value of sales. As a proxy for sales the value of final expenditure (FEV) was used[13]. For the import duties equation, in addition to the value of total imports (MGV) its lagged value was also included in order to capture possible effects of lagged imports of goods on duties. But its coefficient was statistically insignificant (t value 0.56). When only the lagged imports of goods were included in the equation, it resulted in a lower fit than that with current imports.

Finally, the time trend proved statistically significant and was included in the selected equation. Thus:

6.4.3 $$\underset{}{DUT} = \underset{(2.32)}{884.384} + \underset{(21.44)}{0.1186MGV_t} + \underset{(4.37)}{192.399T}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ $DW = 1.33$ $SEE = 810.2$

As the Durbin-Watson statistic is in the inconclusive region, the equation was re-estimated for a first order autocorrelation. Although the value of the Durbin-Watson statistic indicated the absence of autocorrelation (DW = 1.77), the coefficient of autocorrelation (ρ) was statistically insignificant and the above equation (6.4.3) was thus retained.

For the rest of indirect taxes (IT) equation, the inclusion of the lagged final expenditure (FEV) gave better results, shown below, concerning the summary statistics than those obtained by using the current one. Using both the current and the lagged final expenditure rendered the former statistically insignificant, thus:

$$IT = -\underset{(2.73)}{2807.8} + \underset{(41.90)}{0.939}FEV_t$$

$R^2 = 0.98$ $\bar{R}^2 = 0.98$ DW = 0.69 POS. SEE = 3399.92

6.4.4 $$IT = -\underset{(4.84)}{4419.7} + \underset{(49.58)}{0.1145}FEV_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.28 INC. SEE = 2794.64

The time trend was statistically insignificant in both equations. When in the equation (6.4.4) the constant term was supressed the magnitude of the Durbin-Watson statistic pointed to positive autocorrelation in the residuals (DW = 0.64), while the standard error of estimate increased to 3972.9. When the above equation (6.4.4) was estimated by generalised least squares, the value of the Durbin-Watson statistic indicated the absence of first order autocorrelation in the residuals (DW = 1.84). As the relevant coefficient (ρ) was statistically insignificant, it was decided to retain (6.4.4) in the model. For the reasons already mentioned for the direct taxes, the sum of predictions, generated by the equations (6.4.3) and (6.4.4) for the period 1978-1980 were compared with the actual figures of total indirect taxes. These forecasts do not correspond closely with the actual figures. For the first two years, the equations underestimate the value of indirect taxes by an amount of 24 billion drs, while for the third year indirect taxes are overestimated by about 20 billion drs. This forecasting weakness is reflected in the corresponding figures for the root mean square forecasting error and the root mean square percentage forecasting error for total indirect taxes (15.6 billion drs and 7.2% respectively).

Subsidies

The value of government subsidies (SUBV) was related to the value of the consumption of non-durables (CNDV). This variable was taken as a proxy, to account for the different factors which influence subsidies. An attempt was made to disentangle the effects of these factors by including in the equation, in apart from the consumption of non-durables, the value of exports of goods and of agricultural production. Both these variables were statistically insignificant. As an increase in the number of unemployed could lead also to the increase of subsidies, this variable was then included in the equation, but it was similarly statistically insignificant. The time trend and the dummy variable (D74) were also included in the equation with the following results:

$$\underset{}{SUBV} = -\underset{(9.55)}{3052.63} + \underset{(31.42)}{0.126CNDV} - \underset{(8.35)}{372.061} + \underset{(1.25)}{972.48D74}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 0.73 POS. SEE = 730.28

As there is positive autocorrelation in the residuals, the equation was re-estimated for a first order autocorrelation, thus:

6.4.5

$$\underset{}{SUBV} = \underset{(1.47)}{2056.68} + \underset{(18.06)}{0.1367CNDV} - \underset{(3.85)}{514.113T} + \underset{(3.81)}{1631.79D74} \qquad \underset{(5.31)}{\rho = 0.75}$$

$R^2 = 0.98$ $\bar{R}^2 = 0.98$ DW = 1.42 INC. SEE = 534.025

All the coefficients are statistically significant and the fit of the equation is very high. Although this equation is corrected for autocorrelation, the value of the Durbin-Watson statistic is in the inconclusive region. Despite some efforts, no better equation was found. The forecasting performance of the equation does not fare satisfactorily either. Subsidies were increased from 28.5 billion drs in 1977 to 33.5 billion in 1978 and remained in almost the same level in 1979. But the equation estimates of subsidies are about 36 billion drs for 1978 and a figure of 44 billions in 1979. This is reflected in the root mean square percentage forecasting error with a magnitude of almost 25% while the figure for the RMSE was 8 billion drs (the value of the $Z_1(2)$ statistic was extremely large).

6.5 Other estimated equations

In order to close the model, it was necessary to estimate functions for some other variables. These variables were required either for constructing another variable (Agricultural production used to calculate productivity) or as explanatory variables in estimated equations (like the non-wage income employed in the direct taxes function), or in calculating identities (the depreciation variable utilized in the derivation of disposable income).

In estimating equations for these variables the primary interest was not in making a detailed analysis to determine the main factors explaining them, but in deriving simple equations, which could closely track their path through time and forecast them satisfactorily.

Agricultural production (AGPR) was related to domestic and foreign demand factors. To account for the influence of these factors the consumption of non-durables and the exports of goods were used as proxy variables respectively. Both these variables were statistically insignificant (the value of the t statistic was less than one). Moreover, the exports of goods had a negative sign. Similar results were obtained when these explanatory variables were lagged one year. The volume of world exports did not improve the results when used as a proxy for foreign demand in the place of Greece's exports of goods.

The consumer price index was also included in the equation with these two variables or with the consumption of non durables only. It was used as a proxy for the prices the producers expect to receive. As agricultural production involves a considerable time cycle, the price variable was lagged by one year. An increase in the prices received by producers could induce an increase in the supply of agricultural products, so a positive sign is expected for the price variable. The results were unsatisfactory. The price coefficient was statistically insignificant and with a negative sign. The time trend had also no significant impact, while the use of log linear functions produced the same pattern of insignificant and wrong signed coefficients.

Finally agricultural production was related to disposable income (DY), deflated by the consumer price index, as the main factor determining domestic demand, with the following results:

6.5.1 $$\Delta GPR = \underset{(18.37)}{22971.3} + \underset{(16.35)}{0.0952}DY$$

$$R^2 = 0.92 \qquad \bar{R}^2 = 0.92 \qquad DW = 1.77\ \text{N.A.} \qquad SEE = 2598.9$$

The inclusion of Greece's total exports of goods or world exports of goods in the above equation produced insignificant of wrong signs for their coefficients, and thus equation (6.5.1) was retained. The root mean square percentage forecasting error was calculated and its magnitude was slightly over 7% while the figure for the RMSE is 3.8 billion drs. Thus the equation forecasts rather satisfactorily which is also indicated by the value 4.443 of the $Z_1(2)$ statistic which is inside the critical one (5.992).

The non-wage income was best explained by changes (first differences) in the value of the gross national product, a time trend for the long term influence of the growth of the economy and the lagged dependent variable to account for the effects of the past changes in the value of GNP. The estimated equation gave the following results:

6.5.2 $$NWYV_t = \underset{(3.24)}{4199.56} + \underset{(22.24)}{0.907}\left[GNPV_t - GNPV_{t-1}\right] + \underset{(37.32)}{0.742}NWYV_{t-1} + \underset{(6.77)}{1107.57}T$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 2.69\ \text{INC.} \qquad SEE = 2400.25$$

Because of the value of the Durbin-Watson statistic, the equation was re-estimated for a first order autocorrelation. As the autocorrelation coefficient was statistically insignificant the above equation was retained. This equation, which does not purport to explain the non-wage income determination, has satisfactory statistical properties. It has a very high fit over the estimation period, while outside the sample it closely forecasts the figures for non-wage income as the low value of 0.75% of the root mean square percentage forecasting error indicates. (The value of the RMSE is 4.9 billion drs.) It should be noted that the value 12.533 of $Z_1(3)$ statistic is outside the critical value (7.815) and indicates that the parameters are not constant outside the sample period.

Depreciation (DEPR) depends on the capital stock, its age composition, and laws according to which firms decide their depreciation policy. As the estimated equation has not been employed to explain the complexity of factors determing capital consumption, but as a forecasting instrument, it was based on the simple assumption that depreciation is a constant fraction of the total capital stock existing at each period. A time trend was also included in the equation, to account for the effects of changes in depreciation policies or changes in the composition of capital stock[14]. Thus the equation for depreciation is:

6.5.3 $$DEPR_t = a_1 K_t + a_2 T$$

where DEPR is the capital consumption given in the national accounts and it has been deflated by the implicit deflator of GNP at market prices K_t is real capital stock at time t and T is the time trend.

The above equation was lagged by one period and the resulting one was subtracted from (6.5.3) giving:

6.5.4 $\quad \Delta DEPR_t = a_1(K_t - K_{t-1}) + a_2$

The term in brackets $(K_t - K_{t-1})$ is the real gross fixed investment (TFI) at period t. Thus this variable was inserted in the above equation and the error term was also added. Thus the finally estimated equation relates changes in depreciation (ΔDEPR) to total fixed investment:

6.5.5 $\quad \Delta DEPR_t = a_1 TFI_t + a_2 + u_t$

As the autocorrelation coefficient was found statistically insignificant (t value 0.47) the following equation estimated by ordinary least squares was retained[(15)]

6.5.6 $$\Delta DEPR_t = \underset{(1.90)}{-\ 306.177} + \underset{(10.02)}{0.0273} TFI_t$$

$R^2 = 0.83 \qquad \bar{R}^2 = 0.82 \qquad DW = 1.72$ N.A. $\qquad SEE = 334.94$

$Z_1(3) = 10.413$

By using the equation (6.5.6) forecasts for ΔDEPR were generated for the years 1978-1980 and then the level of depreciation for these years was obtained by employing the identity

$$DEPR_t = DEPR_{t-1} + \Delta DEPR_t$$

These derived figures of depreciation were closely tracking the actual ones as the value of 2.3% for the root mean square percentage forecasting error indicates (the corresponding figure for the RMSE was 0.8 billion drs).

FOOTNOTES TO CHAPTER 6

1. M.R. Killingsworth, "A Critical Survey of Neo-classical Models of Labour", The Bulletin of the Oxford University Institute of Economics and Statistics, 32 (1970), 133-165.

2. D.W. Challen and A.J. Hagger, "Demand for Labour Functions: the Wrong Track?", The Oxford Bulletin of Economics and Statistics, 44 (1982), 31-57.

3. Killingsworth, op. cit., p. 139.

4. P.J. Dhrymes, "A Model of Short-run Labour Adjustment", in The Brooking Model: Some Further Results, eds. J. Duesenberry et. al., 1969.

5. Dhrymes, op. cit., p. 113.

6. R.C. Fair, A Short-run Forecasting Model of the US Economy, Lexington 1971, ch. 7.

7. Fair, op. cit.

8. T. Hazeldine, "Employment and Output Function for New Zealand in Manufacturing Industries", The Journal of Industrial Economics, 22 (1973-1974). Also D.A. Peel and I. Walker, "Short-run Employment Functions, Excess Supply and The Speed of Adjustment: a Note", Economica, 45-46 (1978-1979), 195-202.

9. Peel and Walker, op. cit.

10. Data for employment and unemployment are taken from several issues of the OECD (Labour force statistics) and ILO statistics (unemployment seamen are excluded).

11. ILO statistics.

12. Non wage income consists of the following items of the national accounts: agricultural income, income from property and entrepreneurship accruing to households, savings and taxes as corporations.

13. Final expenditure consists of private domestic consumption expenditure (excluding expenditure of non residents) plus total investment (fixed and stocks), exports of goods and services and governments current expenditure on goods and services.

14. M.D. McCarthy, "Analysis of Non Wage Income Components", in The Brooking Model, op. cit.

15. The estimate below of 0.027 for the depreciation rate is comparable to that (0.021) found by I. Adelman and H.B. Chenery: "Foreign Aid and Economic Development: the Case of Greece", Review of Economics and Statistics, 48 (1966).

7. INTERNATIONAL TRANSACTIONS

7.1 Introduction

Imports play a very important role in the economy of the country, not only because they meet part of the demand for goods and services but also - and especially from the long-run point of view of economic development - because they are the main source of the indispensable products of advanced technology and much needed capital equipment. The response then of imports to fluctuations in economic activity and relative prices has serious repercussions both for the country's transactions with other nations (balance of payments) and for their effects on domestic production and employment. Total imports of goods and services as a percentage of GNP (at market prices), both expressed in 1970 prices, was about 10% in 1974, reached a figure of around 24% in 1973 and was reduced to 21% in 1977. At the same time, the average annual rate of growth of them exceeded 9%. As can be seen from Table 7.3 (in Appendix 1), the value of imports of manufactured goods (5-9 categories of SITC classification) always exceeded the value of the imported goods of the rest (0-4) of SITC categories. This trend was maintained and reinforced throughout the sample period 1954-1977, albeit with fluctuations. The share of the value of manufactured goods to the total value of imports of goods, from 54% in 1954, increased to 67% in 1961 and was maintained to over 60% up to the end of the sample period.

Because of the already stressed importance of imports on the balance of payments and on domestic production, and as the various categories of imported goods may respond differently to changes in economic activity and prices, it was decided that the proper process would be to treat imports of goods at a dissaggregated level, even if the present analysis has certain weaknesses concerning the price indeces employed.

The significance of exports of goods and services is not confined only to the employment and incomes they generate; it also refers to the fact that they provide the necessary resources for payment of the country's imports. The export sector of the economy is relatively small. The share of export of goods and services to GNP (both in 1970 prices), was ranging between 7-10% up to 1970 and then increased to 14.5% at the end of the sample period (Table 7.1 Appendix 1). The average annual rate of growth of export of goods and services is slightly over 9% (Table 7.3).

The most impressive feature is the changes in the composition of the kind of goods exported (Table 7.3 in Appendix 1). The share of the value of the exported manufactured goods (5-9 categories of SITC classification) from less than 10% in the early years of the sample period reached the figure of 55% in 1977. The importance of the expenditure of non-residents (mainly tourists) for the country's earnings in foreign currency should be also stressed, as this item of the invisible account has increased in real terms more than ten times during the years covered in the sample (Table 7.1, Appendix 1).

An attempt was also made to estimate equations for the income and transfer receipts and payments of the country's international transactions, because of the importance of these items in reducing the almost permanently increasing deficit of the balance of payments for goods and services, whose seriousness is revealed by the figures of the Table 7.2 (Appendix 1).

Because of the importance of international trade, theories have been advanced to explain the trade and its conditions between countries.

7.2 Theories of International Trade

The theory of international trade attempts, on the one hand to show that trade is beneficial for all the groups in a society and not only for the immediate participants (exporters - importers), and on the other hand to establish the minimum conditions for the existence of trade such as differences in prices. The main task of the theory of international trade was to explain these price differences and why they may persist. There are two main theories which try to answer these problems.

According to the theory of comparative advantage, trade allows every country to gain by exporting those commodities for which it has a comparative advantage. That is each country produces and trades the commodities which can be produced relatively inexpensively at home before trade, and imports the goods which can be produced at relatively high cost.

This theory states that the pattern of trade will be determined by technological differences between countries, which are reflected in differences in relative costs. The comparative advantage theory then asserts that trade will take place, if the marginal opportunity cost of producing any commodity will be different between countries. Assuming perfect competition, price will equal marginal cost and thus, different marginal opportunity costs will result in different prices, and consequently trade will take place.

The result of trade will be an increase in the quantity of goods available for consumption than before trade, which implies an increase in welfare. The theory does not make any assumption about productivity or take into account income distribution effects, while it assumes full employment[1]. At the same time the theory of comparative advantage does not show what the price is going to be, but, in the simple model of two countries - two commodities it demonstrates that trade will be profitable for both countries as long as the price, at which the two countries exchange the commodities, lies between their marginal opportunity costs.

The main rival to comparative advantage theory is the factor-endowment model, which is based on the assumption that the factors of production are homogeneous and relatively mobile in a country, but not mobile between countries. According to this theory countries would have liked to trade in factor services, but because they are not mobile, they trade goods instead.

Thus a country will export those commodities which their production requires the relatively intensive use of factors found in relative abundance in the country. As a result of trade the differences in the returns of the factors of production, such as wages, rents between countries, tend generally to be equated.

As both these theories are based on restrictive assumptions and their empirical applications have not succeeded in explaining the pattern and the increase in world trade, especially in recent times, new theories have been expounded, which by taking into consideration other factors, try to account for the movements and the expansion of world trade.

Thus, differences in tastes between countries are considered as one of the main factors in explaining international trade, while it is also argued that differences in technology could account for it. For example the technological gap and the product cycle theories argue that technologically advanced countries invent and export new products to other less technologically advanced countries. The latter, after some period of time, could acquire the necessary technology to imitate, produce and then export these products to other countries (including those which have invented them); but at the same time the advanced technologically countries may have produced new goods of high technology.

The existence of economies of scale in identical countries could lead to increased welfare by specialisation as the theory of economics of scales states, while the availability theory argues that trade takes place in goods which are available in one country and cannot be produced in others because of the lack of natural resources. Availability is also influenced by product differentiation and technical improvements.

Finally the variety hypothesis(2), based on the concept of the characteristics of goods desirable by purchasers, stresses the importance and the effects of increases in real incomes in explaining the growth of world trade.

7.3 Imports of Goods

Imported goods have not been considered as homogeneous and close substitutes with those domestically produced. Thus, their demand cannot be considered an excess demand function (Kemp M.C. the pure theory of international trade 1964).

In the case of homogeneous goods, imports are not demanded for their own sake; they are the result of shortages in the domestic production, which cannot satisfy demand at the prevailing price. Thus, the import function is the difference between the demand and supply functions of the particular goods. In most cases, however, the imported goods are not homogeneous and cannot be considered perfect substitutes of domestic production. Traded goods may have differences not only in their physical characteristics, but also in other aspects such as quality, styles, which may qualify them as different goods. Because of differences in tastes people may perceive goods, although having the same physical characteristics, as different such as clothing, and fashion goods. If imported goods were close subsitutes to domestically produced (and so they were imported to satisfy the demand which could not be met by domestic production) the expanding two way trade could not be explained for many products such as textiles, cars, consumer durables (domestic appliances), plastic materials, chemical products, etc. In addition, many goods necessary to the production process or wanted for consumption are not produced in the country. Especially countries with developing economies, that want to increase and diversify production into new lines, depend to a large extent on imports of capital goods, raw materials and semi finished goods. In all these cases the imported goods are demanded in their own right and thus the excess demand formulation breaks down. As Barker has pointed out[3], the excess demand approach cannot explain the increasing two ways trade in goods such as textile fibres, motor vehicles etc.

Following this line of approach and taking into account that Greece's economic growth and consumption patterns depend heavily on imported goods not produced in the country or not offered in varieties of satisfactory quality (Table 7.1 Appendix 1) imported goods in this study have been considered to be demanded for their own sake and an importdemand function is postulated. It has been assumed that basically the desired level of import demand for goods is a function of an activity of expenditure variable and on the relative price, that is the ratio of the price of imported goods to the domestic price. As changes in activity variables or prices require time, so that their impact should be reflected on the desired level of the volume of imports, a stock adjustment mechanism has also been postulated.

The import demand model may be presented as

7.3.1 $$M^*_t = a_o + a_1 Y_t + a_2 \frac{PM}{PD} t + u_t$$

7.3.2 $$M_t - M_{t-1} = b\,(M^*_t - M_{t-1}) \quad o \leq \; b \geq 1$$

where M^*_t is the desired level of real imports

M_t the actual level of real imports

Y_t is an activity of expenditure value

PM is the import price

PD is the domestic price

u_t is the error term

and b is the adjustment coefficient.

According to the postulated adjustment mechanism, the change in the current quantity of imports demanded $(M_t - M_{t-1})$ is a positive function of the difference between the desired (long-run) demand for imports in the current period to the actual demand in the previous period. That is, the actual quantity of imports adjusts with a time lag to the desired level of imports. The speed of adjustment depends on the coefficient of adjustment b. The closer b is to unity the faster the adjustment will take place.

Substituting equation (7.3.1) into (7.3.2) and rearranging terms we get the equation to be estimated as (7.3.3).

7.3.3 $$M_t = a_o b + a_1 \, bY_t + a_2 b \frac{PM}{PD} t + (1-b)M_{t-1}$$

In the import demand model (as indeed in any other demand model[4]) the quantity of goods demanded is negatively related to their price and equilibrium is reached by the interaction of demand and supply. As Greece is a small country and its imports form only a tiny fraction of total world exports, it is reasonable to assume an infinite elasticity of supply of imports[5].

Concerning the problem of selecting a linear or a log-linear functional form to estimate equation (7.3.3), it should be mentioned that there are no clear cut criteria for choosing between them, as Leamer and Stern have pointed out[6]. So, for each category of imported goods the above import demand function (7.3.3) was estimated both in linear and log-linear form and the choice between them was based on the standard statistical criteria.

The estimated equations of the basic import demand model are

$$M_t = a_o b + a_1 bY_t + a_2 b \frac{PM}{PD} t + (1-b)M_{t-1} + u_t \tag{7.3.3}$$

or

$$nM_t = a_o b + a_1 b \; nY_t + a_2 b \; n \frac{PM}{PD} + (1-b) \; nM_{t-1} + u_t \tag{7.3.4}$$

Greece's total imports of goods have been grouped into the following six categories, based on the Standard International Trade Classification (SITC) of ten broad categories (0-9):

(i) M01 Imports of foods (0) beverages and tobacco (1).

(ii) M24 Imports of crude inedible materials - except fuels (2) and Imports of oils and fats (4).

(iii) M3 Import of fuels, lubricants etc. (3).

(iv) M56 Imports of chemicals (5) and imports of manufactured goods classified by raw material. Many of the items in these categories are characterised as intermediate goods and can be used further in the production process.

(v) M7 Imports of machinery and transport equipment (7). The largest part in this group consists of capital goods (excluding ships - category 735).

(vi) M89 Miscellaneous manufactured goods (8) and not classified commodities (9).

An activity variable is included in the import demand function, to account for the effect which an increase of the level of this variable, say GNP, has on trade. An increase in the GNP could lead to an increase in imports as more and different goods will be required to meet a higher demand, which could not be satisfied by the domestic production alone. Hence a positive coefficient is expected for this variable. There are several possibilities for the choice of the activity variable to be used, e.g. GNP or final expenditure. As the analysis of imports is here conducted at a more disaggregated level, the usual practice has been adopted, that is using as activity variables those parts of final demand more closely associated to the import group under consideration(7).

This practice has the disadvantage that no consistent relation exists between the various parts of final demand and the SITC classification of goods(8).

As it has been said above, the import demand model is conceptually similar to any demand model. Hence the volume of imports is inversely related to the price of imported goods (PM) and the price of domestic products (PD) which can be used as substitutes, even if not close enough. Under the further assumption of absence of money illusion, the relative price, that is the ratio of these two prices, enters the equation (7.3.3) as explanatory variable(9).

For import prices (PM) the unit value index of total imports(10) was used, having been adjusted for exchange rates movements. The proper procedure would have been to use the available unit value indices for each of the categories of the SITC and then construct weighted averages, when necessary, so that each of the six groups of commodities into which total imports have been classified has its own unit value index. However, the average unit value index of total imports has been used instead, for each of the six groups. The reasons for this are: firstly, to economize for estimation purposes on the number of exogenous variables in the whole model compared with the small number of observations; and secondly, to maintain the balance in the whole model by avoiding a relatively large number of price equations with respect to the total number of structural equations in the model. This would have made the whole model very sensitive to the accumulated errors particularly from the price equations. Instead, the average unit value index of total imports has been used for each of the six groups, for the following reasons.

The average unit value index of total imports approximates reasonably the general trend of the particular unit value indices of SITC categories, with the notable exception of the unit value index for fuels for the last years of the sample period. As the relevant price determining the demand for imports is the price charged to buyers, the unit value index of total imports has been adjusted by including tariffs. An average duty rate (DR) for each year was calculated by dividing the duty taxes of that year by the value total imports. Then the unit value index of total imports with tariffs (PMD) included was calculated by the formula PMD = PM (1 + DR).

For the price of domestic product, the implicit deflator of gross national product (at market prices) was used, on the grounds that it approximates closely the price of domestically produced substitutes of imported goods. For some of the import categories analysed, instead of using the implicit deflator for GNP, more particular implicit deflators, like those of consumption of nondurables and equipment investment were used. From what has been said, it is clear that the relative prices used in imports functions do not constitute a proper price variable and hence the estimates of their coefficients should be interpreted with great caution.

According to economic theory one of the most important factors in explaining international trade is the fluctuations in the relative prices of traded goods. At the same time, estimated models of import and export use relative prices as one of their main explanatory variables[(11)]. Thus, despite the defects of the price variable used in the import equations, it was thought that it would be better to attempt to have a measure - even if not a proper one - of the effects of relative prices, than commit from the beginning of the analysis a specification error, by excluding relative prices fromthe import demand functions. A time trend was also used as explanatory variable to account for the effect of other factors contributing to the demand for imports, such as changes in tastes. A Dummy variable was introduced to account for the increase in the price of oil (D74). In order to capture the effects of domestic supply shortages, which could lead to increasing imports, the difference between total expenditure, excluding changes in stocks, and gross domestic product, taken as a measure of demand pressure (DP) was also used.

For each of the above six categories into which total imports have been grouped, several equations based on the basic model (7.3.3) and (7.3.4) were estimated by ordinary least squares.

The equations which produced satisfactory results were also estimated for a first order auto correlation scheme ($u_t = \rho u_{t-1} + v_t$) by the generalised least squares procedures described previously. In the results that follow, figures in brackets below the estimates of the coefficients are the absolute values of the t statistic and all the variables are expressed in real terms, except if otherwise stated.

M01

For the imports of the SITC categories 0 and 1, which include foodstuffs, live animals, beverages and tobacco, the disposable income deflated by the consumers price index and the volume of consumption of non-durables were used alternatively as activity variables, with results almost similar with respect to the standard statistical criteria ($\bar{R}^2$, DW etc). The relative price variable (as previously defined, the ratio of the unit value index of total imports adjusted for tariffs, to the implicit deflator of GNP), when entered the imports function had the correct (negative) sign, but it was statistically insignificant (the value of the t statistics was less than one). In the deonominator of the relative price variable, instead of the GNP implicit deflator, the consumer price index and the implicit deflator of consumption of nondurables were also used. Their coefficients, although with the correct sign, were statistically insignificant. As the value of the DW statistic for the equations with relative prices was in the inconclusive region (whether the activity variable was the disposable income or the consumption for nondurables) the equations were estimated by the procedure of generalised least squares (described in previous chapter) for first order autocorrelation.

The results below show a high degree of serial correlation in the residuals, the relevant coefficient (p) ranging between 0.80 and 0.90. The coefficients of the price variables were now statistically significant. At the same time, the goodness of fit of the equations decreased, the $\bar{R}^2$ ranging between 0.45 and 0.75, while in some equations the coefficient of the lagged dependent variable became negative. This result violates the assumption of the basic model (7.3.2), that the adjustment coefficient b does not exceed one.

$$\ell nMO1_t = \underset{(0.83)}{0.224} + \underset{(3.39)}{0.597}\ell nDY_t - \underset{(0.81)}{0.251}\ell n\frac{PMD}{CPI} \times 100 + \underset{(1.46)}{0.261}\ell nMO1_{t-1}$$

$R^2 = 0.93$ $\bar{R}^2 = 0.92$ DW = 1.50 INC. SEE = 0.115

$$\ell nMO1_t = -\underset{(0.06)}{0.181} + \underset{(3.24)}{0.594}\ell nDY_t - \underset{(0.61)}{0.152}\ell n\frac{PMD}{PCND} \times 100 + \underset{(1.42)}{0.257}\ell nMO1_{t-1}$$

$R^2 = 0.93$ $\bar{R}^2 = 0.92$ DW = 1.50 Inc. SEE = 0.116

7.3.5 $$\ell nMO1_t = \underset{(0.83)}{4.786} + \underset{(3.96)}{1.555}\ell nDY - \underset{(2.07)}{1.3705}\ell n\frac{PMD}{CPI} \times 100 + \underset{(0.32)}{0.057}\ell nMO1_{t-1}$$

$\rho = \underset{(9.68)}{0.90}$ $R^2 = 0.53$ $\bar{R}^2 = 0.45$ DW = 2.21 N.A. SEE = 0.102

$Z_1(2) = 0.103$

7.3.6 $$\ell nMO1_t = \underset{(0.42)}{1.973} + \underset{(3.71)}{0.9907}\ \ell nDY - \underset{(1.85)}{1.201}\ell n\frac{PMD}{PCND} \times 100 + \underset{(0.14)}{0.0261}\ell nMO1_{t-1}$$

$\rho = \underset{(6.25)}{0.80}$ $R^2 = 0.58$ $\bar{R}^2 = 0.51$ DW = 2.14 N.A. SEE = 0.103

$Z_1(2) = 0.438$

Both equations (7.3.5) and (7.3.6) were tested for the constancy of the parameters outside the sample period (forecasting accuracy), by calculating the statistic $Z_1(k) = \Sigma(\frac{f_i}{\sigma})^2$ for the two subsequent years (1978,1979), for which data exist. The results suggest a small preference for the equation (7.3.5). For the first equation the value of Z_1 statistic is $Z_1(2) = 0.103$ and the second has a slightly worse value of 0.438 but both within the critical value (χ^2 distribution with 2 degrees of freedom) which is 5.992. The cumulative forecasting absolute error is 408 million drs for the first equation and almost double (765 million drs) for the second. Taking into consideration that, because of the large magnitude of ρ (0.90) the equation (7.3.5) is estimated like an almost first difference form, the value of $\bar{R}^2$ could not be considered unsatisfactory.

The demand pressure (DP) variable, when included together with the disposable income or the volume of consumption of nondurables, was always statistically insignificant. When only this variable was included in an equation (in apart from the lagged dependent variable) the fit of the equation was inferior to those with disposable income or the consumption of nondurables. In this case the coefficient of the demand pressure variable was positive and statistically significant in the linear function, but insignificant when a log-linear function was estimated. The use of the first differences of demand pressure produced a coefficient positive but statistically insignificant, with its standard error exceeding its magnitude. These results could tentatively suggest that the demand pressure variable picks some of the effects of the activity variables. It should be mentioned that the log-linear estimated functions produced a better fit to the data than the linear ones.

The time trend variable was statistically significant and its inclusion improved the goodness of fit and lowered the standard error of estimate of the equations.

$$\underset{}{\ell nMO1} = \underset{(3.33)}{-13.453} + \underset{(4.45)}{1.743}\ell nDY + \underset{(1.42)}{0.2127}\ell n\ MO1_{t-1} \underset{(3.04)}{-0.0777}T$$

$R^2 = 0.957$ DW = 1.69 N.A.

$\bar{R}^2 = 0.95$ SEE = 0.0964

When this equation was estimated for a first order autocorrelation scheme, the following results confirmed the absence of autocorrelation in the residuals.

$$\ell nMO1 = \underset{(3.48)}{-13.633} + \underset{(4.50)}{1.7101}\ell n^{DY} + \underset{(1.86)}{0.282}\ell nMO1_{t-1} \underset{(3.16)}{-0.0781}T$$

$\rho = \underset{(0.21)}{0.00}$ $\bar{R}^2 = 0.951$

$R^2 = 0.958$ DW = 2.04 N.A. SEE = 0.0934

It should be noted that when in the above equation the disposable income was replaced by the consumption of non-durables variable it resulted in a negative sign for the coefficient of the lagged dependent variable, violating the assumption (7.3.2), that the adjustment coefficient b is less or equal to one. So this equation was tested for forecasting accuracy by calculating the $Z_1(k)$ statistic for the subsequent two years. The value of $Z_1(2)$ is 16.687, well above the critical one of 5.992, leads to the rejection of the null hypothesis of the constancy of the parameter outside the sample period. It should be added that the cumulative forecasting absolute error is more than ten times larger than the corresponding figure for the preferred equation (7.3.5), reaching the value of 4453 million drs. The inclusion of disposable income or consumption of non durables, lagged one year, gave less satisfactory results. The Dummy variable was always insignificant, as it can be seen from the following sample of the equations estimated for these two (0 and 1) SITC import categories.

$$\underset{}{MO1} = \underset{(1.41)}{444.09} + \underset{(3.74)}{0.0156DY} + \underset{(1.46)}{0.271\ MO1_{t-1}}$$

$$R^2 = 0.91 \qquad \bar{R}^2 = 0.90 \qquad DW = 1.75\ \text{N.A.} \qquad SEE = 621.42$$

$$MO1 = \underset{(1.85)}{-1056.109} + \underset{(3.48)}{0.0571\ CND} + \underset{(0.94)}{0.204\ MO1_{t-1}}$$

$$R^2 = 0.909 \qquad \bar{R}^2 = 0.90 \qquad DW = 1.77\ \text{N.A.} \qquad SEE = 638.79$$

$$MO1 = \underset{(2.39)}{-1945.46} + \underset{(3.42)}{0.086\ CND} - \underset{(1.48)}{0.043\ DP_{t-1}} + \underset{(1.003)}{0.211\ MO1_{t-1}}$$

$$R^2 = 0.918 \qquad \bar{R}^2 = 0.90 \qquad DW = 2.07\ \text{N.A.} \qquad SEE = 621.02$$

$$MO1 = \underset{(1.45)}{464.48} + \underset{(2.83)}{0.013DY} + \underset{(0.70)}{0.0214\ \Delta DP} + \underset{(1.61)}{0.329\ MO1_{t-1}}$$

$$R^2 = 0.91 \qquad \bar{R}^2 = 0.90 \qquad DW = 1.94\ \text{N.A.} \qquad SEE = 628.97$$

$$\ell nMO1 = \underset{(2.27)}{-4.458} + \underset{(2.76)}{0.863\,\ell n\ CND} + \underset{(1.81)}{0.368\,\ell nMO1_{t-1}}$$

$$R^2 = 0.93 \qquad \bar{R}^2 = 0.92 \qquad DW = 1.77\ \text{N.A.} \qquad SEE = 0.128$$

$$\ell n MO1 = \underset{(1.10)}{-1.224} + \underset{(2.03)}{0.469} \ell n DY_{t-1} + \underset{(2.13)}{0.474} \ell n MO1_{t-1}$$

$R^2 = 0.92$ $\bar{R}^2 = 0.91$ DW = 2.002 N.A. SEE = 0.137

$$\ell n MO1 = \underset{(1.31)}{-2.728} + \underset{(1.75)}{0.579} \ell n\ CND_{t-1} + \underset{(2.58)}{0.55} \ell n MO1_{t-1}$$

$R^2 = 0.918$ $\bar{R}^2 = 0.91$ DW = 2.05 N.A. SEE = 0.14

$$\ell n MO1 = \underset{(1.37)}{-1.416} + \underset{(9.81)}{0.798} \ell n DY + \underset{(1.67)}{0.0288} \ell n MO1_{t-1} \underset{(0.66)}{-0.173} \ell n \frac{PMD}{PGNPM}$$

$R^2 = 0.94$ $\bar{R}^2 = 0.93$ DW = 1.11 INC SEE = 0.117

$$\ell n MO1 = \underset{(1.15)}{-1.288} + \underset{(8.95)}{0.788} \ell n DY + \underset{(1.60)}{0.0285} \ell n MO1_{t-1} \underset{(0.71)}{-0.199} \ell n \frac{PMD}{PGNPM}$$

$$+ \underset{(0.34)}{0.044} D74$$

$R^2 = 0.946$ $\bar{R}^2 = 0.934$ DW = 1.14 INC SEE = 0.119

$$\ell n MO1 = \underset{(1.95)}{2.721} + \underset{(5.55)}{0.975} \ell n DY - \underset{(0.476)}{0.0829} \ell n MO1_{t-1} \qquad \rho = \underset{(3.08)}{0.55}$$

$R^2 = 0.773$ $\bar{R}^2 = 0749$ DW = 2.02 N.A. SEE = 0.107

$$\ell n MO1 = \underset{(2.90)}{-7.186} + \underset{(4.91)}{1.4802} \ell n\ CND - \underset{(0.73)}{0.144} \ell n\ MO1_{t-1} \quad \rho = \underset{(3.51)}{0.60}$$

$R^2 = 0.69$ $\bar{R}^2 = 0.66$ DW = 1.85 N.A. SEE = 0.115

$$\ell n MO1 = \underset{(0.26)}{-1.031} + \underset{(4.30)}{1.267} \ell n\ CND - \underset{(1.86)}{0.987} \ell n \frac{PMD}{CPI} \times 100$$

$$- \underset{(0.06)}{0.0135} \ell n MO1_{t-1} \qquad \rho = \underset{(5.08)}{0.55}$$

$R^2 = 0.77$ $\bar{R}^2 = 0.74$ DW = 1.91 N.A. SEE = 0.108

$$\ell nM01 = \underset{(3.57)}{-28.239} + \underset{(4.88)}{3.606}\,\ell n\, CND - \underset{(2.74)}{0.664}\,\ell n\,\frac{PMD}{CPI} \times 100$$

$$+ \underset{(0.40)}{0.063}\,\ell nM01_{t-1} \underset{(3.56)}{-0.116T}$$

$R^2 = 0.96$ $\bar{R}^2 = 0.95$ DW = 1.48 INC SEE 0.0926

$Z_{1(2)} = 1.405$

$$\ell nM01 = \underset{(3.53)}{-40.146} + \underset{(4.14)}{4.572}\,\ell n\, CND - \underset{(0.92)}{0.164}\,\ell nM01_{t-1} \underset{(2.98)}{-0.147T} \quad \underset{(2.36)}{\rho = 0.45}$$

$R^2 = 0.86$ $\bar{R}^2 = 0.84$ DW = 1.89 N.A. SEE 0.0975

$$\ell nM01 = \underset{(1.38)}{-9.479} + \underset{(3.80)}{2.284}\,\ell n\, CND \underset{(3.15)}{-1.9204}\,\ell n\,\frac{PMD}{PCND} \times 100$$

$$+ \underset{(0.46)}{0.0814}\,\ell nM01_{t-1} \quad \underset{(9.68)}{\rho = 0.90}$$

$R^2 = 0.55$ $\bar{R}^2 = 0.84$ DW = 1.86 N.A. SEE 0.1001

$Z_{1(2)} = 0.7598$

$$\ell nM01 = \underset{(3.15)}{-33.236} + \underset{(4.11)}{4.185}\,\ell n\, CND - \underset{(2.15)}{0.697}\,\ell n\,\frac{PMD}{CPI} \times 100$$

$$- \underset{(0.41)}{0.073}\,\ell nM01_{t-1} \underset{(3.14)}{-0.136T} \quad \underset{(1.47)}{\rho = 0.30}$$

$R^2 = 0.92$ $\bar{R}^2 = 0.92$ DW = 1.67 INC SEE 0.0904

In the selected equation (7.3.5) and in most of those of the above sample the coefficient of the lagged dependent variable is small in magnitude, implying a fast adjustment of the actual quantity of imports category M01 to changes in the long run demand for imports.

M24

For the imports of SITC categories 2 and 4, which include raw materials (excluding fuels), oil and fats, the gross national product (GNP) and the index of industrial production (IIP) were alternatively used as activity variables without considerable differences regarding the fit of the equation, while those with GNP performed slightly better. The relative price variable (the ratio of the unit value index of total imports adjusted for tariffs to the implicit deflator of GNP) was always significant at the 5 per cent level. But, when it was included in the equations estimated in log linear form, the coefficient of the lagged dependent variable became negative, thus implying a magnitude in excess of one for the adjustment coefficient (b). The finally selected equation for the imports M24 was the following linear one:

7.3.7

$$M24 = \underset{(3.34)}{4296.65} + \underset{(4.21)}{0.0332}\,GNP + \underset{(1.82)}{0.3089}M24_{t-1}$$

$$-\underset{(3.52)}{30.985}\,\frac{PMD}{PGNPM} - \underset{(2.55)}{327.294}T$$

$R^2 = 0.969$ $\bar{R}^2 = 0.963$ DW = 2.08 N.A. SEE 362.22

$Z_1(2) = 39.465$

When the above equation was estimated for a first order autocorrelation the results confirmed the absence of autocorrelation in the residuals.

$$M24 = \underset{(3.46)}{4267.18} + \underset{(4.16)}{0.0331}\,GNP + \underset{(2.08)}{0.356}M24_{t-1}$$

$$- \underset{(3.61)}{30.671}\,\frac{PMD}{PGNPM} - \underset{(2.62)}{340.102}T \quad \rho = -\underset{(0.47)}{0.10}$$

$R^2 = 0.973$ $\bar{R}^2 = 0.966$ DW = 2.04 N.A. SEE=369.293

The autocorrelation coefficient ρ, small in magnitude, is statistically insignificant and less its standard error. The null hypothesis of constancy of the parameters outside the sample period is rejected for the equation (7.3.7), as the value 39.465 of the $Z_1(2)$ statistic well exceeds the critical value of 5.992. (The cumulative forecasting absolute error is 3,193 million drs.) As no other equation was found satisfactory on the grounds of forecasting accuracy and the equation (7.3.7) has the expected signs in the coefficients, which are statistically significant and satisfies the summary statistics, it was decided to be retained into the model.

The inclusion of lagged activities variables or their first differences simultaneously with the current ones resulted in insignificant coefficients and sometimes with the wrong signs (it has been already explained that an increase of the activity variable could lead, ceteris paribus, to an increase in imports, and thus a positiv sign is expected), as the following sample of equations estimated for the demand of this category of imports shows. The use of the variable changes in stocks (inventory investment, II) did not improve the results, its coefficient being always insignificant; the dummy variable was also statistically insignificant.

$$M24 = \underset{(1.64)}{379.93} + \underset{(2.90)}{22.72}\,IIP + \underset{(2.32)}{0.447}\,M24_{t-1}$$

$R^2 = 0.93$ $\bar{R}^2 = 0.93$ DW = 1.60 N.A. SEE = 499.79

$$M24 = \underset{(1.87)}{378.46} + \underset{(2.60)}{52.078}\ IIP - \underset{(2.07)}{42.28}\ IIP_{t-1} + \underset{(1.88)}{0.387}\ M24_{t-1} + \underset{(1.54)}{83.65}T$$

$R^2 = 0.95$ $\bar{R}^2 = 0.95$ DW = 2.09 N.A. SEE = 428.6

$$M24 = \underset{(2.31)}{636.35} + \underset{(0.85)}{8.24}\ IIP + \underset{(1.12)}{0.031}\ II + \underset{(0.76)}{0.163}\ M24_{t-1} + \underset{(2.39)}{140.5}T$$

$R^2 = 0.95$ $\bar{R}^2 = 0.94$ DW = 1.51 INC SEE = 459.67

$$M24 = \underset{(1.07)}{-250.4} + \underset{(2.42)}{0.0137}\ GNP + \underset{(1.64)}{0.023}\Delta GNP + \underset{(1.78)}{0.389}\ M24_{t-1}$$

$R^2 = 0.95$ $\bar{R}^2 = 0.95$ DW = 1.97 N.A. SEE = 415.16

$$M24 = \underset{(1.68)}{1460.9} + \underset{(5.20)}{0.0168}\ GNP + \underset{(0.46)}{0.073}\ M24_{t-1} \underset{(2.08)}{-9.85} \frac{PMD}{PGNPM}$$

$R^2 = 0.96$ $\bar{R}^2 = 0.95$ DW = 1.67 N.A. SEE = 402.9

$$\ell nM24 = \underset{(2.58)}{2.538} + \underset{(2.67)}{0.562}\ell nIIP + \underset{(1.83)}{0.396}\ell nM24_{t-1}$$

$R^2 = 0.95$ $\bar{R}^2 = 0.94$ DW = 1.68 N.A. SEE = 0.123

$$M24 = \underset{(3.42)}{4502.83} + \underset{(4.24)}{0.0355}GNP + \underset{(0.68)}{0.164}M24_{t-1} \underset{(2.53)}{-327.179}T + \underset{(0.86)}{488.77}D74 - \underset{(3.59)}{32.31}\frac{PMD}{PGNPM}$$

$R^2 = 0.97$ $\bar{R}^2 = 0.96$ DW = 2.15 N.A. SEE = 364.77

$$\ell nM24 = \underset{(2.38)}{-17.659} + \underset{(3.05)}{2.09}\ell nGNP + \underset{(0.74)}{0.143}\ell nM24_{t-1} - \underset{(1.71)}{0.068}T$$

$R^2 = 0.96$ $\bar{R}^2 = 0.96$ DW = 1.69 N.A. SEE = 0.102

$$\ell nM24 = -\underset{(2.70)}{17.02} + \underset{(3.90)}{2.15}\ell nGNP - \underset{(2.01)}{0.069}T - \underset{(2.69)}{0.487}\ell n\frac{PMD}{PGNPM}$$

$R^2 = 0.97$ $\bar{R}^2 = 0.97$ DW = 1.94 N.A. SEE = 0.088

$$\ell nM24 = -\underset{(2.62)}{16.77} + \underset{(3.81)}{2.137}\ell nGNP - \underset{(1.93)}{0.068}T - \underset{(2.73}{0.519}\ell n\frac{PMD}{PGNPM}$$

$$- \underset{(0.65)}{0.091}\ell n\, M24_{t-1}$$

$R^2 = 0.97$ $\bar{R}^2 = 0.97$ DW = 1.91 N.A. SEE = 0.089

In the selected equation (7.3.7) the coefficient of lagged dependent variables implies a rapid adjustment of actual imports to its desired level, as the magnitude of the adjustment coefficient b is 0.6911 (slightly less than six months).

M3 Imports of fuels

The GNP was the main activity variable for the demand of imports of this category. The use of the index of industrial production, instead of GNP, did not improve the results, as can be seen in the following sample of the estimated equations. An attempt was made to disentangle the impact of industrial production and direct consumption of fuel products on these imports, by including the index of industrial production and the consumption of non-durables. When these two variables were included simultaneously, both were statistically insignificant and, in addition, the coefficient of consumption of nondurables was negative. As the Greek economy depends on the imports of fuels, and as there is no domestic production, at least not of an important scale, no relative price variable was included in the estimated equation.

The unit value index of total imports (current or lagged) was employed, although it does not approximate closely the oil price.

It resulted in the wrong signs for the coefficients of GNP and the lagged dependent variable. The finally selected equation is a linear function of GNP, of the lagged dependent variable, the time trend and the dummy variable accounting for the oil price increase in 1974. It has the correct signs and satisfies the statistical criteria, while the corresponding log linear function has the wrong (negative) sign in the coefficient of the lagged dependent variable.

$$M3 = -\underset{(2.34)}{2384.49} + \underset{(2.28)}{0.0366}GNP + \underset{(8.62)}{0.746}M3_{t-1} + \underset{(4.45)}{4732.43}D74 - \underset{(1.65)}{315.029}T$$

$$R^2 = 0.97 \qquad \bar{R}^2 = 0.964 \qquad DW = 1.69 \text{ N.A.} \qquad SEE\ 999.203$$

When the equation was re-estimated to allow for a first order autocorrelation scheme, it was found that the residuals exhibit a significant negative autocorrelation, as the magnitude of the autocorrelation coefficient is -0.60 and exceeds more than twice its standard error. Thus, the following equation adjusted for autocorrelation is retained in the model:

7.3.8

$$M3 = -\underset{(2.88)}{1935.07} + \underset{(2.70)}{0.0296}GNP + \underset{(13.83)}{0.802}M3_{t-1} + \underset{(6.28)}{6516.89}D74 - \underset{(1.92)}{252.38}T \qquad \rho = -\underset{(3.51)}{0.60}$$

$$R^2 = 0.988 \qquad \bar{R}^2 = 0.985 \qquad DW = 2.11 \text{ N.A.} \qquad SEE = 983.332$$

$$Z_1(2) = 20.248$$

The value 20.248 of the Z_1 statistic, calculated from the forecast figures of equation (5.3.8) for the years 1978-1979, indicates that the null hypothesis of parameters constancy should be rejected (critical value 5.992). The cumulative forecasting absolute error for the two years is 4,741 million drs. As in the case of the import category M24, no other satisfactory equation was found and the equation (7.3.8) for the imports M3 was retained in the model.

The sample of other estimated equations for M3 imports is:

$$M3 = \underset{(1.53)}{1063.08} + \underset{(2.37)}{0.0113}GNP_{t-1} + \underset{(9.44)}{0.803}M3_{t-1} + \underset{(4.04)}{4560.01}D74$$

$R^2 = 0.96$ $\bar{R}^2 = 0.96$ DW = 1.65 N.A. SEE = 1033.75

$$M3 = -\underset{(1.63)}{1662.76} + \underset{(2.14)}{0.0342}CND_{t-1} + \underset{(9.98)}{0.862}M3_{t-1} + \underset{(4.21)}{4769.03}D74$$

$R^2 = 0.96$ $\bar{R}^2 = 0.96$ DW = 1.61 N.A. SEE = 1055.16

$$\ell nM3 = -\underset{(5.75)}{12.364} + \underset{(8.38)}{1.686}\ell nGNP - \underset{(0.15)}{0.007}\ell nM3_{t-1} + \underset{(1.82)}{0.600}D74$$

$R^2 = 0.88$ $\bar{R}^2 = 0.86$ DW = 0.47 POS SEE = 0.312

$$\ell nM3 = \underset{(9.55)}{0.577} + \underset{(2.73)}{0.483}\ell nJIP_{t-1} + \underset{(3.75)}{0.686}\ell nM3_{t-1} + \underset{(2.04)}{0.338}D74$$

$R^2 = 0.97$ $\bar{R}^2 = 0.96$ DW = 2.33 N.A. SEE = 0.154

$$\ell nM3 = \underset{(1.01)}{10.859} - \underset{(0.95)}{1.54}\ell nCND_{t-1} + \underset{(1.53)}{1.24}\ell nIIP_{t-1} + \underset{(4.72)}{0.629}\ell nM3_{t-1} + \underset{(1.56)}{0.278}D74$$

$R^2 = 0.97$ $\bar{R}^2 = 0.96$ DW = 2.35 INC SEE = 0.154

$$M3 = -\underset{(1.91)}{1035.34} + \underset{(2.88)}{0.0096GNP} + \underset{(13.65)}{0.839M3_{t-1}} + \underset{(5.73)}{6212.29D74} \qquad \rho = -\underset{(2.36)}{0.45}$$

$$R^2 = 0.98 \qquad \bar{R}^2 = 0.98 \qquad DW = 1.91 \text{ N.A.} \qquad SEE = 1049.88$$

In most of the estimated equations the coefficient of the lagged dependent variable was large in magnitude, implying a slow adjustment of the actual imports to the desired level.

The mean lag of the selected equation (7.7.8), which slightly exceeds 4 years, seems rather long, calling into question the appropriateness of employing the geometric lag distribution as adjustment mechanism for this category of imports.

M56

The imports category M56 includes chemicals (5) and manufactured goods, classified chiefly by raw material (6). Some of the items included in these categories can be further used in the production process while others can satisfy the final demand. The inclusion of either GNP or the index of industrial production in the estimated functions gave almost similar results. Thus, the equation with the former as activity variable was retained. The relative price variable specified the ratio of the unit value index of total imports adjusted for tariffs to the implicit deflator of GNP was always statistically significant and with the right sign. As it has been explained the demand for imports model is similar to any demand model and thus a negative sign is expected for the coefficient of the price variable. When the demand pressure variable was also included, it was statistically insignificant and sometimes the activity variable became negative. The formulation of the finally selected equation was log-linear, as this form gave better results (on economic theory and statistical grounds) than the linear equations.

The equation retained in the model is the following:

7.3.9
$$\ell nM56 = \underset{(0.33)}{0.3259} + \underset{(4.69)}{0.7715}\ell nGNP + \underset{(2.06)}{0.2749}\ell nM56_{t-1} - \underset{(4.87)}{0.6209}\ell n \frac{PMD}{PGNPM} \times 100$$

$$R^2 = 0.992 \qquad \bar{R}^2 = 0.991 \qquad DW = 1.70 \text{ N.A.} \qquad SEE = 0.05057$$

As the results show, the absence of first order autocorrelation in the residuals was confirmed when the above equation was estimated by generalised least squares. The autocorrelation coefficient ρ was statistically insignificant and less its standard error.

$$\ell nM56 = \underset{(0.05)}{0.0634} + \underset{(5.05)}{0.837}\ell nGNP + \underset{(1.59)}{0.2137}\ell nM56_{t-1} - \underset{(4.43)}{0.6175}\ell n \frac{PMD}{PGNPM} \times 100 \qquad \rho = \underset{(0.71)}{0.15}$$

$$R^2 = 0.989 \qquad \bar{R}^2 = 0.987 \qquad DW = 2.06 \text{ N.A.} \qquad SEE = 0.0486$$

The following is a set of equations estimated for the imports category M56

$$M56 = \underset{(1.38)}{583.24} + \underset{(1.57)}{31.06}IIP + \underset{(2.08)}{0.406}M56_{t-1} + \underset{(2.22)}{274.19}T$$

$$R^2 = 0.97 \qquad \bar{R}^2 = 0.96 \qquad DW = 1.21 \text{ INC.} \qquad SEE = 972.69$$

$$\underset{}{M56} = \underset{(1.73)}{532.8} + \underset{(4.81)}{157.18IIP} - \underset{(4.30)}{141.23IIP_{t-1}} + \underset{(4.01)}{0.598M56_{t-1}}$$

$$+ \underset{(1.72)}{161.73T}$$

$R^2 = 0.98 \quad \bar{R}^2 = 0.98 \quad DW = 180 \text{ N.A.} \quad SEE = 740.01$

$$\ell nM56 = \underset{(1.29)}{0.858} + \underset{(0.85)}{0.134\ell nIIP} + \underset{(5.87)}{0.849\ell nM56_{t-1}}$$

$R^2 = 0.98 \quad \bar{R}^2 = 0.98 \quad DW = 1.52 \text{ N.A.} \quad SEE = 0.0813$

$$\ell nM56 = \underset{(1.50)}{2.508} - \underset{(0.38)}{0.102\ell nIIP} + \underset{(4.21)}{0.7406\ell nM56_{t-1}} + \underset{(1.08)}{0.027T}$$

$R^2 = 0.98 \quad \bar{R}^2 = 0.98 \quad DW = 1.58 \text{ N.A.} \quad SEE = 0.081$

$$\ell nM56 = \underset{(1.00)}{1.848} - \underset{(3.49)}{0.798\ell nIIP_{t-1}} + \underset{(1.82)}{0.297\ell nDP} + \underset{(5.23)}{0.74\ell nM56_{t-1}}$$

$$+ \underset{(3.06)}{0.059T}$$

$R^2 = 0.989 \quad \bar{R}^2 = 0.987 \quad DW = 1.83 \text{ N.A.} \quad SEE = 0.065$

$$\ell nM56 = \underset{(0.33)}{0.337} + \underset{(3.79)}{0.801\ell nGNP} + \underset{(1.34)}{0.246\ell nM56_{t-1}} - \underset{(3.89)}{0.645\ell n}\frac{PMD}{PGNPM}x100$$

$$+ \underset{(0.28)}{0.018D74}$$

$R^2 = 0.99 \quad \bar{R}^2 = 0.99 \quad DW = 1.68 \text{ N.A.} \quad SEE = 0.05187$

$$\ell nM56 = \underset{(6.06)}{8.134} + \underset{(4.75)}{0.585\ell nIIP} + \underset{(2.01)}{0.268\ell nM56_{t-1}} - \underset{(5.46)}{0.791\ell n}\frac{PMD}{PGNPM} \times 100$$

$R^2 = 0.99 \quad \bar{R}^2 = 0.99 \quad DW = 1.43 \text{ INC} \quad SEE = 0.0502$

The retained equation (7.3.9) suggests a rapid adjustment of actual to the long run level of imports M56, as the magnitude 0.725

of the adjustment coefficient b implies (about 5 months). The null hypothesis of parameters constancy could be accepted as the value 5.86 of the $Z_1(2)$ statistic is just inside the critical value 5.992, while the cumulative forecasting absolute error is 3,747 million drs.

M7

As this category includes capital and consumer durable goods (machinery and transport equipment), the total gross fixed investment (TFI) or the expenditure on construction and equipment investment (CEI) and the consumer expenditure on durables (CD) were used as activity variables. The relative price variable used was the ratio of the unit value index of total imports adjusted for tariffs (PMD), divided either by the implicit deflator of GNP or CPI, or the implicit deflator of the equipment investment. The coefficients of both of them were statistically insignificant and less than their standard errors. The lagged dependent variable for this imports category was almost always statistically insignificant and negative. It was thus dropped and the equations with satisfactory results were re-estimated. The equations estimated in logarithmic form had a $\bar{R}^2$ as high as the linear equations, but the value of the Durbin Watson statistic in most of them was either in the inconclusive region or pointed to the existence of positive autocorrelation.

The demand pressure variable (DP), the time trend and the dummy variable which accounts for possible effects of the increase in the price of oil, were statistically insignificant, the value of the t-statistic barely exceeding in some equations the value of unity.

From the different combinations of the activities variables tried, the best results were obtained when the current year's total investment or construction and equipment investment and the lagged expenditure of consumer's durables were included simultaneously. Thus

$$M7 = -\underset{(5.98)}{2351.72} + \underset{(13.16)}{0.2066}TFI + \underset{(4.05)}{0.0904}CD_{t-1}$$

$R^2 = 0.988$ $\bar{R}^2 = 0.986$ DW = 1.46 N.A. SEE = 804.345

7.3.10 $$M7 = -\underset{(3.62)}{1890.81} + \underset{(9.07)}{0.297}CEI + \underset{(2.18)}{0.0739}CD_{t-1}$$

$R^2 = 0.98$ $\bar{R}^2 = 0.97$ DW = 1.44 N.A. SEE = 1105.45

The above equations were re-estimated by generalised least squares procedure for a first order autocorrelation, but as the following results show the autocorrelation coefficient is statistically insignificant in both equations.

$$M7 = -\underset{(4.60)}{2582.12} + \underset{(11.14)}{0.2114}TFI + \underset{(3.41)}{0.0895}CD_{t-1} \qquad \rho = \underset{(1.21)}{0.25}$$

$R^2 = 0.97$ $\bar{R}^2 = 0.97$ DW = 1.63 N.A. SEE = 807.008

$$M7 = -\underset{(2.98)}{2271.32} + \underset{(7.60)}{0.3109}CEI + \underset{(1.70)}{0.0687}CD_{t-1} \qquad \rho = \underset{(1.21)}{0.25}$$

$R^2 = 0.96$ $\bar{R}^2 = 0.96$ DW = 1.60 N.A. SEE = 1101.77

Both equations were tested for parameters constancy for the two years 1978-79. The null hypothesis of parameters constancy is rejected for the first equations (with total fixed investment) as the value 21.329 of the Z_1 statistic exceeds the critical value 5.992, while it is accepted for the second equation (with construction and equipment investment) as the value 1.014 of the Z_1 statistic is less than the critical one. The cumulative forecasting absolute error is 5,188 million drs for the former and 1,571 million dollars for the latter. It was thus decided to retain the equation (7.3.10) with the construction and equipment investment as activity variable.

A sample of equations estimated for the imports of machinery and transport equipment follows:

$$M7 = \underset{(1.00)}{-\ 2168.1} + \underset{(1.46)}{0.248TFI} + \underset{(0.93)}{0.074DP_{t-1}} - \underset{(0.21)}{0.161M7_{t-1}}$$

$R^2 = 0.928$ $\quad \bar{R}^2 = 0.91$ $\quad$ DW + 1.65 N.A. $\quad$ SEE = 2040.2

$$M7 = \underset{(0.82)}{-\ 2030.56} + \underset{(8.73)}{0.2057TFI} + \underset{(3.33)}{0.089CD_{t-1}} - \underset{(0.08)}{1.05}\frac{PMD}{PGNPM} \times 100$$

$R^2 = 0.987$ $\quad \bar{R}^2 = 0.985$ $\quad$ DW = 1.39 INC $\quad$ SEE= 844.9

$$\ell nM7 = \underset{(5.28)}{-\ 3.25} + \underset{(6.14)}{0.96\ell nTFI} + \underset{(2.47)}{0.277\ell nM7_{t-1}}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad$ DW = 1.09 INC $\quad$ SEE = 0.0768

$$\ell nM7 = \underset{(13.88)}{-\ 5.26} + \underset{(14.92)}{1.256\ell nTFI} + \underset{(1.36)}{0.099\ell nCD_{t-1}}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.989$ $\quad$ DW = 0.92 POS. $\quad$ SEE = 0.0836

$$\ell nM7 = \underset{(0.96)}{-\ 4.89} + \underset{(18.26)}{1.302\ell nTFI} + \underset{(0.64)}{0.007\ell nCD_{t-1}} - \underset{(0.74)}{0.192\ell n}\frac{PMD}{PGNPM} \times 100 + \underset{(0.31)}{0.0304D74}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad$ DW = 0.98 INC. $\quad$ SEE = 0.089

$$M7 = -\underset{(4.60)}{2610.3} + \underset{(9.63)}{0.215}TFI + \underset{(2.92)}{0.0988}CD_{t-1} - \underset{(0.41)}{0.045}M7_{t-1} \qquad \rho = \underset{(0.95)}{0.20}$$

$R^2 = 0.981 \qquad \bar{R}^2 = 0.978 \qquad DW = 1.61$ N.A. $\qquad SEE = 825.36$

$$M7 = -\underset{(0.24)}{779.3} + \underset{(5.52)}{0.295}CEI + \underset{(1.73)}{0.0764}CD_{t-1} - \underset{(0.47)}{8.08}\frac{PMD}{PEI} \times 100$$

$$\rho = \underset{(1.2)}{0.25}$$

$R^2 = 0.96 \qquad \bar{R}^2 = 0.95 \qquad DW = 1.64$ N.A. $\qquad SEE = 1124.97$

$$M7 = \underset{(0.63)}{2816.53} + \underset{(5.03)}{0.255}CEI + \underset{(2.33)}{0.108}CD_{t-1} - \underset{(1.07)}{30.69}\frac{PMD}{CPI} \times 100$$

$R^2 = 0.978 \qquad \bar{R}^2 = 0.975 \qquad DW = 1.54$ INC. $\qquad SEE = 1101.34$

M89

For this imports categories (miscellaneous manufactured goods and not classified commodities) the expenditure of consumption of durables (CD) was used as the activity variable. The unit value index of total imports adjusted for tariffs (PMD) was divided by the consumers' price index (CPI), the implicit deflator of GNP (PGNP) and the implicit deflator of consumption of durables (PCD). These three relative price variables were included separately in succession in the impo demand function. Although in almost all cases they had the expected negative sign, they were invariably statistically insignificant. Whether the current or the lagged activity variable was used the coefficient was always statistically significant. Equations estimated in logarithmic form resulted in wrong signs, either in the activity variable or in the lagged dependent one.

The dummy variable (D74) was always statistically significant, its coefficient exceeding many times its standard error. Thus, the following equation for the demand of imports M89 was retained in the model

7.3.11 $$\underset{}{M89} = \underset{(0.77)}{25.849} + \underset{(3.92)}{0.0105CD} + \underset{(9.76)}{0.841M89_{t-1}} - \underset{(8.77)}{779.64D74}$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.989 \qquad DW = 2.04 \text{ N.A.} \qquad SEE = 74.47$$

The adjustment of actual imports to the desired level follow a slow process, as the small magnitude of the adjustment coefficient (b = 0.16) indicates. The implied mean lag is slightly more than 5 years, casting doubts on the use of the distributed lag with geometrically declining weights as the adjustment mechanism, for this input function.

The following equations are a sample of those tried for this imports category:

$$M89 = \underset{(0.96)}{236.063} + \underset{(3.65)}{0.0149CD_{t-1}} + \underset{(5.09)}{0.715M89_{t-1}}$$

$$\underset{(8.48)}{814{\cdot}568D74} - \underset{(11.08)}{1.386} \frac{PMD}{PGNPM} \times 100$$

$$R^2 = 0.991 \qquad \bar{R}^2 = 0.989 \qquad DW = 2.24 \text{ N.A.} \qquad SEE = 74.68$$

$$M89 = \underset{(1.05)}{216.82} + \underset{(4.48)}{0.0149CD_{t-1}} + \underset{(6.24)}{0.7201M89_{t-1}}$$

$$- \underset{(9.64)}{890.761D74} - \underset{(1.18)}{1.386} \frac{PMD}{PGNPM} \times 100 \qquad \underset{(1.75)}{\rho = 0.35}$$

$$R^2 = 0.994 \qquad \bar{R}^2 = 0.993 \qquad DW = 2.00 \text{ N.A.} \qquad SEE = 73.84$$

$$\ell nM89 = \underset{(10.67)}{5.944} - \underset{(4.74)}{1.233}\ell nCD_{t-1} + \underset{(4.91)}{1.98}\ell nM89_{t-1} - \underset{(0.24)}{0.289}\ell n\frac{PMD}{PGNPM}$$

$R^2 = 0.87$ $\bar{R}^2 = 0.85$ DW = 1.006 INC. SEE = 0.255

$$\ell nM89 = \underset{(3.02)}{1.292} + \underset{(21.65)}{0.879}\ell nCD - \underset{(3.07)}{0.046}\ell nM89_{t-1} - \underset{(7.00)}{1.141}\ell n\frac{PMD}{PGNPM}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 0.80 POS. SEE = 0.075

$$\ell nM89 = -\underset{(3.44)}{1.501} + \underset{(21.86)}{0.897}\ell nCD - \underset{(3.07)}{0.044}\ell nM89_{t-1}$$
$$- \underset{(6.63)}{1.079}\ell n\frac{PMD}{PGNPM} - \underset{(1.52)}{0.12}D74$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 0.86 POS. SEE = 0.072

$$M89 = -\underset{(0.94)}{24.837} + \underset{(5.03)}{0.0121}CD_{t-1} + \underset{(12.07)}{0.830}M89_{t-1} - \underset{(11.65)}{944.86}D74$$

$$\rho = \underset{(1.75)}{0.35}$$

$R^2 = 0.994$ $\bar{R}^2 = 0.993$ DW = 1.90 N.A. SEE = 74.66

$Z_{1(2)} = 7.476$

$$M89 = \underset{(1.19)}{278.53} + \underset{(3.53)}{0.0148}CD + \underset{(5.16)}{0.701}M89_{t-1} - \underset{(6.02)}{683.47}D74$$
$$- \underset{(1.32)}{2.096}\frac{PMD}{PCD} \times 100$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.95 N.A. SEE = 73.03

$$M89 = \underset{(1.09)}{302.88} + \underset{(3.95)}{0.0135CD} + \underset{(5.96)}{0.725M89_{t-1}} - \underset{(6.88)}{757.88D74}$$

$$- \underset{(1.18)}{2.169}\frac{PMD}{PCD} \times 100 \qquad \rho = \underset{(1.21)}{0.25}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad DW = 1.89$ N.A. $\quad SEE = 74.52$

$$M89 = \underset{(1.05)}{214.004} + \underset{(3.90)}{0.0162CD_{t-1}} + \underset{(6.06)}{0.715M89_{t-1}} - \underset{(9.60)}{889.51D74}$$

$$- \underset{(1.18)}{1.675}\frac{PMD}{PCD} \times 100 \qquad \rho = \underset{(1.75)}{0.25}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad DW = 1.94$ N.A. $\quad SEE = 73.81$

The selected equation (7.3.11) was re-estimated to allow for a first order autocorrelation scheme in the residuals. The results below show that the hypothesis of first order autocorrelation cannot be accepted, as the autocorrelation coefficient ρ is statistically insignificant (at 5% level of significance). The equation performs satisfactorily outside the sample period. The value 1.832 of the Z_1 statistic is less than the critical one 5.992, which indicates that the null hypothesis of the constancy of the parameters outside the sample can be accepted, while the cumulative forecasting absolute error is 134 million drs.

Summary of the Demand Functions of the Imports of Goods

The analysis has been conducted at a disaggregate level and the following equations were selected as adequately explaining the data for each import category described at the beginning of this chapter.

7.3.5 $$\ell nMO1 = -\underset{(0.83)}{4.786} + \underset{(3.96)}{1.555}\ell nDY - \underset{(2.07)}{1.3705}\ell n \frac{PMD}{CPI} \times 100 + \underset{(0.32)}{0.057}\ell nMO1_{t-1} \qquad \rho = \underset{(9.68)}{0.90}$$

$R^2 = 0.53$ $\bar{R}^2 = 0.45$ DW = 2.21 N.A. SEE = 0.102

$Z_1(2) = 0.103$

7.3.7 $$M24 = \underset{(3.34)}{4296.65} + \underset{(4.21)}{0.0332}GNP + \underset{(1.82)}{0.3089}M24_{t-1} - \underset{(2.55)}{327.294}T - \underset{(3.52)}{30.985}\frac{PMD}{PGNPM} \times 100$$

$R^2 = 0.96$ $\bar{R}^2 = 0.96$ DW = 2.08 N.A. SEE = 362.22

$Z_1(2) = 39.465$

7.3.8 $$M3 = -\underset{(2.88)}{1935.07} + \underset{(2.70)}{0.0296}GNP + \underset{(13.83)}{0.802}M3_{t-1} + \underset{(6.28)}{6156.89}D74 - \underset{(1.92)}{252.38}T \qquad \rho = \underset{(3.51)}{-0.60}$$

$R^2 = 0.98$ $\bar{R}^2 = 0.98$ DW = 2.11 N.A. SEE = 983.33

$Z_1(2) = 20.248$

7.3.9 $$\ell nM56 = \underset{(0.33)}{0.3259} + \underset{(4.69)}{0.7715}\ell nGNP + \underset{(2.06)}{0.2749}\ell nM56_{t-1} - \underset{(4.87)}{0.6209}\ell n \frac{PMD}{PGNPM} \times 100$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.70 N.A. SEE = 0.05057

$Z_1(2) = 5.8606$

7.3.10 $$M7 = - \underset{(3.62)}{1890.81} + \underset{(9.07)}{0.297}CEI + \underset{(2.18)}{0.0739}CD_{t-1}$$

$R^2 = 0.98$ $\bar{R}^2 = 0.97$ DW = 1.44 N.A. SEE = 1105.45

$Z_1(2) = 1.014$

7.3.11 $$M89 = - \underset{(0.77)}{25.849} + \underset{(3.92)}{0.0105}CD + \underset{(9.76)}{0.841}M89_{t-1} - \underset{(8.77)}{779.64}D74$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.04 N.A. SEE = 74.47

$Z_1(2) = 1.832$

(For the above import categories the equations estimated by the 2SLS procedure resulted in estimates almost similar to those of OLS estimation.)

The activity and price variables in the above equations have the expected signs and are statistically significant. The goodness of fit is very high and the selected equations explain between 0.96 and 0.99 of the variance in the data, except for the first equation (7.3.5). Nevertheless, the lower value of R^2 could not be considered unsatisfactory, as this equation corrected for autocorrelation, has been estimated in an almost first differences form (because of the large value of the autocorrelation coefficient $\rho = 0.90$). Regarding the speed of adjustment of the actual quantity of imports to changes in the long run demand for imports, the above results suggest a short time lag for the import categories M01, M24, M56, M89. The magnitude of the lagged dependent variable implies mean lags for these categories which do not exceed half a year. On the other hand, the implied mean lags for the imports categories M3 and M89 are very long, exceeding four and five years respectively. These results cast some doubts on the appropriateness of the distributed lag with geometrically declining weights for imports, suggesting that other procedures could also be used to determine the lag structure.

Finally, the equations were tested for forecasting accuracy and constancy of the parameters outside the sample period (for the subsequent two years 1978-1979), by calculating the $Z_1(k)$ statistic, which is distributed as x^2 with k degrees of freedom, its critical value being in this particular case 5.992. The results above indicate that the equations for M01, M56, M7, M89 satisfy the test, while for M24 and M3 the value of $Z_1(k)$ is well outside the critical value 5.992.

In addition, the root mean square forecasting error (RMSE) and the root mean square percentage forecasting error (RMSPE) were also calculated for all the selected equations by the formulae:

$$\text{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(X^F - X^A)^2} \quad \text{and} \quad \text{RMSPE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\frac{X^F - X^A}{X^A}\right)^2}$$

where X^F is the forecast value, X^A the actual value and N the number of forecasting periods.

The results are as follows:

IMPORTS CATEGORIES

In million 1970 drs.

	M01	M24	M3	M56	M7	M89
RMSE	213.21	1608.06	3127.76	1873.88	786.93	70.84
			Percentages			
RMSPE	2.34	26.21	14.96	9.04	3.56	2.23

Because of their importance, especially in the international trade, the elasticities for the activity and relative price variables were calculated for each of the selected equations. In addition to short run elasticities, the long run ones were also calculated and the results are given in the following table.

An aggregate import demand function (MG) was estimated in linear and log-linear form, using GNP as activity variable, and the ratio of the unit value index for total imports, adjusted for tariffs to the implicit deflator of GNP, as the relative price. As GNP is the result of the final demand items and imports, its use could pose a simultaneity problem. The TSLS procedure was employed for both the linear and log-linear functions. The estimates of the coefficients were almost similar with those obtained by OLS estimation, suggesting that simultaneity is not a serious problem in the case of imports.

ELASTICITIES

	Income - Activity Variables								Relative Prices			
	GNP		DY		CEI		CD		PMD / CPI		PMD / PGNPM	
	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long
M01			1.555	1.649					-1.3705	-1.453		
M24	1.824	2.639									-1.171	-1.694
M3	1.245	6.288										
M56	0.771	1.063									-0.6209	-0.856
M7					0.971		0.205*					
M89							0.276	1.731				

*For M7 this variable is lagged one year

The time trend was then included and proved statistically significant for the linear equation and insignificant for the log linear. But as the time trend led to a slight improvement in the summary statistics and at the same its coefficient exceeded its standard error, it was retained in the log linear equation as well. Finally, both equations were re-estimated for a first order autocorrelation and the results revealed the absence of significant autocorrelation in the residuals, as in both of them the magnitude of the autocorrelation coefficient was small and the value of the t statistic less than one. Thus, the following were the preferred equations estimated by ordinary least squares.

7.3.12
$$MG = \underset{(2.07)}{17638.5} + \underset{(7.22)}{0.304GNP} - \underset{(3.60)}{186.022}\frac{PMD}{PGNPM} \times 100 + \underset{(2.66)}{0.368MG_{t-1}} - \underset{(3.52)}{2499.3T}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad DW = 1.85$ N.A. $\quad SEE = 1877.28$

$Z_{1(3)} = 22.406$

7.3.13
$$\ell nMG = -\underset{(1.95)}{7.43} + \underset{(4.07)}{1.408\ell nGNP} - \underset{(3.28)}{0.355\ell n}\frac{PMD}{PGNPM} \times 100 + \underset{(1.81)}{0.265\ell nMG_{t-1}} - \underset{(1.33)}{0.0284T}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad DW = 1.95$ N.A. $\quad SEE = 0.0497$

$Z_{1(3)} = 1.713$

Both equations satisfy expectations concerning the sign of the price and activity variable coefficients, which are also statistically significant, while the summary statistics are satisfactory for both. The equations differ to other important aspects, concerning the speed of adjustment of actual imports to changes in the long run demand for imports, the magnitude of the price and activities elasticities and their forecasting ability. For both equations the implied magnitude of the adjustment coefficient (b) indicates a short lag of less than a year. The log linear equation has a shorter lag than the linear (about 4 and 7 months respectively). The long run elasticities for the activity variable are 1.916 for the log linear equation and 2.821 for the linear. The magnitude of the long run price elasticity of the former is -0.482, while the latter exhibits a price elasticity of -1.188.

As far as the forecasting ability of the two equations is concerned, the log linear function proved superior. The null hypothesis of parameters constancy was tested by calculating the $Z_1(k)$ statistic for the three subsequent years (1978-1980), for which data for total imports exist. The value of $Z_1(3)$ for the log linear function 1.713 is well inside the critical one 7.815, so the null hypothesis is accepted. This hypothesis is rejected for the linear function, for which the value of $Z_1(3)$ statistic is 22.406. At the same time, the cumulative forecasting absolute error, the root mean square error and the root mean square percentage error are 7,871 million drs, 2,965 million drs and 3.82% respectively for the log linear equation. The corresponding figures for the linear function are 13,371 million drs, 5,130 million drs and 6.60% respectively. Thus, the log linear function (7.3.13) should be preferred, as its results are more satisfactory.

The forecasts derived from the selected equation for total imports (7.3.13) were compared with the sum of those derived from the preferred disaggregate functions for the different import categories. As it can be seen in the following table, (figures in million drs at 1970 prices), the forecasts of the disaggregate functions predict in an equally satisfactory way the level of total imports.

	Imports (1)	Forecasts of the Aggregate Functions (2)	Forecasts of the Disaggregate Functions (3)	Absolute Differences (2) - (1)	Absolute Differences (3) - (1)
1978	77,281	80,846	81,247	3,565	3,966
1979	83,837	83,166	83,809	671	28
TOTAL				4,236	3,994

The root mean square forecasting error and the root mean square percentage forecasting error were also calculated and the figures are very close. For the aggregate function the corresponding figures are 2.6 billion drs and 3.3%, while for the disaggregate data are 2.8 billion drs and 3.6% respectively.

7.4 Exports of Goods

The model employed to explain the exports side of Greece's foreign trade is formally similar to the model used for its imports[(12)]. The demand for exports of goods, as the demand for any good, is positively related to the income of the importing country and negatively to relative price of the goods, which is the ratio of the exporting country's export price of goods to the export price of different suppliers competing in the importing country's market. The relative price variable has been used under the assumption of absence of money illusion.

A proper analysis of exports at a disaggregate level would require the classification of goods not only into different categories but also according to the regions (markets) of their destination(13). As this kind of analysis would demand an increase in the number of exogenous variables relative to the number of observations (unit value indices, and activity variables according to the above classifications), it was decided to estimate a function for the total exports of goods.

Concerning the supply relation of exports, the further assumption is made, that the supply price elasticity of exports of goods is infinite. Although the validity of this assumption is less appealing here than in the case of imports supplied to a small country from the rest of the world, it was decided that it should be retained, as exports of goods are a small part of total output, and variation in them does not change significantly neither the output nor the prices(14).

Assuming for the moment only income and prices as explanatory variables, the export of goods demand function is

7.4.1 $$XG^d = a_o + a_1 WY_t + a_2 \frac{PX}{PWX}t + u_t$$

where XG^d is the volume of exports demanded in the long run, PX is the price of exports, PWX is the price of exports of other countries, and u_t is the random error term.

Furthermore, it is postulated that the actual quantity of exports adjusts after a time lag to the long run demand of exports[15]. To account for this disequilibrium behaviour, the partial adjustment mechanism was used.

7.4.2 $$XG - XG_{t-1} = \gamma \, (XG^{d} - XG_{t-1}) \qquad 0 \leq \gamma \leq 1$$

where γ is the adjustment coefficient.

Change in exports is assumed to adjust to the difference between the demand for exports and the actual quantity in the previous period. The speed of adjustment of the actual to the long run demand for exports is determined by the magnitude of the adjustment coefficient γ, and the faster the speed, the closer γ is to unity.

Substituting the equation (7.4.1) for XG^{d} into (7.4.2) and rearranging the terms, the estimated equation of exports is obtained:

7.4.3 $$XG = a_{o}\gamma + a_{1}\gamma \, WY_{t} + a_{2}\gamma \frac{PX}{PWX} + (1 - \gamma) XG_{t-1} + v_{t}$$

where XG is the volume of Greece's total exports.

The series was constructed by dividing the value of total exports by the unit value index (PXG), WY is the volume of world exports, expressed in USA dollars, taken as a proxy for world income deflated by PWX.

PX = the unit value index of total exports, base 1970, expressed in USA dollars

PWX = the unit value index of world exports, base 1970, expressed in USA dollars

v_{t} = γu_{t} = the random error term.

In addition, the following variables were included in the equation (7.4.1), in order to explain Greece's exports. $\frac{PXG}{PGNPM}$, the ratio of export prices to the implicit deflator of GNP, is used as a proxy for the profitability of exporting relative to selling in the home market. As a higher profitability of exporting will attract resources in the export sector, a positive sign is expected between this ratio and exports volume.

ER = exchange rate, drachmae per USA dollars. A positive sign is expected, as an increase in the units of domestic currency per dollar will lead, ceteris paribus, to increased exports.

T = time trend, to account for possible trends through time, which cannot be explained by the explanatory variables included in the estimated equation.

The basic equation (7.4.3) was enlarged by including the above variable $\frac{PXG}{PGNPM}$ and gave the following results (figures in brackets below the coefficients are absolute values of the t statistic).

7.4.4 $$XG = \underset{(0.60)}{-\,4868.12} + \underset{(4.23)}{0.0751}WY - \underset{(2.06)}{156.475}\frac{PX}{PWX} + \underset{(2.61)}{128.459}\frac{PXG}{PGNPM} + \underset{(2.26)}{0.377}XG_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.32 N.A. SEE = 1425.19

$Z_{1(3)} = 15.227$

The coefficients have the expected signs and are statistically significant (the coefficient of $\frac{PX}{PWX}$ is significant in one tail test). The fit of the equation, measured by $\bar{R}^2$, is very high, while the value of the Durbin-Watson statistic is in the non-autocorrelation region.

The equation failed the test for forecasting accuracy, as the value 15.227 of the Z_1 statistic with three degrees of freedom is higher than the critical one (7.815).

The equation (7.4.4) was re-estimated for a first order autocorrelation process (of the form $v_t = \rho v_{t-1} + \varepsilon_t$). As the results below show, the estimate of the relevant coefficient ρ is statistically insignificant.

$$XG = \underset{(0.74)}{-5085.06} + \underset{(4.19)}{0.0657}WY - \underset{(1.96)}{130.791}\frac{PX}{PWX} + \underset{(2.61)}{113.221}\frac{PXG}{PGNPM}$$

$$+ \underset{(3.16)}{0.478}XG_{t-1} \qquad \rho = \underset{(1.47)}{-0.30}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad DW = 2.24$ N.A. $\quad SEE = 1424.46$

The equation (7.4.4) was estimated by the procedure of 2SLS (using principal components, as described in previous chapter) to take into account the simultaneity effect. It gave the following results:

7.4.5 $$XG = \underset{(1.33)}{42257.6} + \underset{(2.09)}{0.0796}WY - \underset{(1.97)}{565.64}\frac{PX}{PWX} + \underset{(1.07)}{111.736}\frac{PXG}{PGNPM}$$

$$+ \underset{(0.06)}{0.0281}XG_{t-1}$$

$DW = 1.33$ INC $\quad SEE = 2590.58$

The low value of the Durbin Watson statistic and the almost doubled SEE of the equation (7.4.5) cast doubt on how much can these results be trusted. At the same time, however, a comparison with the equation (7.4.4) shows that, while there are not important differences in the magnitude of the coefficients of the variables WY and $\frac{PXG}{PGNPM}$ the magnitude of the coefficient of the relative export price has been increased by more than three times. This result could indicate that the effect of relative export price $(\frac{PX}{PWX})$ is underestimated in the equation (7. 4.4) and calls into question the earlier assumption of infinite elasticity of supply price of exports. When the variable $\frac{PXG}{PGNPM}$, the ratio of export price to the GNP implicit deflator was dropped from the equation (7.4.4), there was a slight deterioration in the fit of the equation. The magnitude of the coefficients of world income (WY) and the relative export price were decreased, the latter being statistically insignificant, as the results below show.

$$XG = \underset{(0.45)}{3749.24} + \underset{(3.28)}{0.0360WY} - \underset{(0.77)}{58.151}\frac{PX}{PWX} + \underset{(5.80)}{0.712XG_{t-1}}$$

$R^2 = 0.98$ $\bar{R}^2 = 0.98$ DW = 2.07 N.A. SEE = 1629.22

$Z_{1(3)} = 9.881$

The other difference between the above and the equation (7.4.4) is that the former's actual volume of exports adjusts with a longer lag to the long run demand for them, as the larger value of the coefficient of the lagged dependent value implies. Although the value of the Z statistic is lower than the one of the equation 7.4.4), it is still outside the critical value. The standard error of estimate of the equation increased from 1425.19 to 1629.22. The result of estimating the above equation by the 2SLS procedure indicates again, as in the case of the equation (7.4.4), that the coefficient of the relative export price is underestimated.

$$XG = \underset{(1.61)}{51393.6} + \underset{(2.25)}{0.0442WY} - \underset{(1.69)}{493.821}\frac{PX}{PWX} + \underset{(1.00)}{0.322XG_{t-1}}$$

DW = 1.28 INC. SEE = 2712.12

In order to assess the effects of the exchange rate movements on exports, this variable ER was included in the equation (7.4.4.) It gave the following results:

7.4.6
$$XG = - \underset{(1.65)}{22170.5} + \underset{(4.44)}{0.0957WY} - \underset{(2.27)}{166.417}\frac{PX}{PWX} + \underset{(3.07)}{153.123}\frac{PXG}{PGNPM}$$
$$+ \underset{(1.57)}{475.125ER} + \underset{(0.60)}{0.135XG_{t-1}}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.06 N.A. SEE = 1370.66

$Z_1(3) = 6.319$

Compared with the (7.4.4), the equation (7.4.6) has an equally good fit, as the value of $\bar{R}^2$ indicates. Its standard error of estimate is lowered from 1425.19 to 1370.66. The explanatory variables have the correct signs and those of the two prices and the world income are statistically significant. The coefficient of the lagged dependent variable is statistically insignificant. The coefficient of the exchange rate has the expected sign. Although it is statistically insignificant, it was decided to be retained in the equation, as the value of the t statistic exceeds unity and its inclusion improved the summary statistics. The magnitude of the Durbin-Watson statistic points to the absence of autocorrelation in the residuals, which was confirmed by re-estimating the equation (7.4.6) for a first order autocorrelation process. The magnitude of the autocorrelation coefficient was small (-0.10) and statistically insignificant ($t = 0.47$).

The other advantage of the equation (7.4.6) is its forecasting ability. Forecasts were generated using this equation for the three years 1978-1980. The null hypothesis of parameters constancy outside the sample period is accepted, as the value 6.319 of Z_1 statistic with three degrees of freedom is less than the critical one (7.815). The cumulative forecasting absolute errors of the equation (7.4.6) is 5.8 billion drs, which is the lowest figure as compared with those calculated from other equations, ranging between 7.2-10 billion drs.

Taking into consideration all the above factors, it was decided to retain the equation (7.4.6) in the model, as adequately explaining the exports of goods.

When included in the export equation, the time trend was statistically insignificant (the t statistic value was less than one). Attempts were also made to assess the impact of domestic demand pressure on exports. The GNP at constant prices and the unemployment rate were interchangeably used asproxy variables for the demand pressure. A negative sign is expected between exports and domestic demand pressure, as an increase in the latter will probably decrease the supplies to the exports sector. From the results below, where a sample of estimated exports equation is presented, it can be seen that both these variables performed unsatisfactorily; they have the wrong sign (positive) and are statistically insignificant. Preliminary estimations of export functions in log-linear form resulted in equations with lower fit and strong indication of autocorrelation in the residuals, as the value of the Durbin-Watson statistic showed. Therefore, no further use of the log-linear form was made.

$$XG = -\underset{(0.76)}{6610.64} + \underset{(3.17)}{0.068}WY - \underset{(1.97)}{19332}\frac{PX}{PWX} + \underset{(2.01)}{170.297}\frac{PXG}{PGNPM}$$

$$+ \underset{(1.62)}{0.318}XG_{t-1} + \underset{(0.61)}{241.102}T$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.36 INC. SEE = 1450.6

$Z_1(3) = 17.335$

$$XG = -\underset{(1.53)}{20557.0} + \underset{(4.14)}{0.092}WY - \underset{(2.24)}{163.959}\frac{PX}{PWX} + \underset{(2.92)}{151.486}\frac{PXG}{PGNPM}$$

$$+ \underset{(0.75)}{0.176}XG_{t-1} + \underset{(1.39)}{427.06}ER \qquad \rho = -\underset{(0.47)}{0.10}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.01 N.A. SEE = 1450.6

$Z_1(3) = 17.335$

$$XG = -\underset{(1.04)}{8570.75} + \underset{(0.44)}{0.0189}WY - \underset{(2.33)}{174.262}\frac{PX}{PWX} + \underset{(3.02)}{155.06}\frac{PXG}{PGNPM}$$

$$+ \underset{(1.43)}{0.0695}GNP + \underset{(2.30)}{0.374}XG_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.27 INC. SEE = 1384.8

$$XG = \underset{(1.12)}{38418.6} + \underset{(0.56)}{0.055}WY_t - \underset{(1.98)}{563.435}\frac{PX}{PWX} + \underset{(1.05)}{130.381}\frac{PXG}{PGNPM}$$

$$+ \underset{(0.27)}{0.032}GNP + \underset{(0.05)}{0.022}XG_{t-1}$$

DW = 1.32 INC. SEE = 2565.5

(The above equation was estimated by the 2SLS procedure.)

$$XG = \underset{(1.33)}{22698.0} + \underset{(4.09)}{0.0815WY} - \underset{(0.32)}{29.43}\frac{PX}{PWX} + \underset{(1.06)}{0.205XG_{t-1}} + \underset{(1.78)}{682.16ER}$$

$$\rho = \underset{(3.08)}{0.55}$$

$R^2 = 0.94$ $\bar{R}^2 = 0.93$ $DW = 1.80$ N.A. $SEE = 1673.9$

$Z_{1(3)} = 9.279$

For the selected equation (7.4.6) the short and long run elasticities of income (WY) and relative prices $(\frac{PX}{PWX})$, the root mean square forecasting error and the root mean square percentage forecasting error were calculated. The short run elasticity with respect to world income is 1.250, while the one for the relative price variable $\frac{PX}{PWX}$ is -0.984. The corresponding long run elasticities are 1.456 and -1.138 respectively. It has already been mentioned that the exports equations, estimated with the 2SLS procedure, despite their statistical weaknesses (the value of the Durbin-Watson statistic and the standard error of estimate) show that the relative price variable $(\frac{PX}{PWX})$ is underestimated. The price elasticity should therefore be cautiously treated. The equations estimated by the 2SLS procedure could not have been corrected for the presence of autocorrelation in the residuals, because of the lack of adequate degrees of freedom. So, the equation (7.4.6) was finally selected, although there are indications of simultaneity bias.

The speed of adjustment of actual exports to their long run demand (when demand is fully adjusted to changes in prices and incomes) is very fast, as the value of the adjustment coefficient (b = 0.865) implies. The estimated mean lag is quite a short one, of slightly less than a quarter of a year. This may be the result of the limitations of the partial adjustment model with geometrically declining weights imposed on the variables[16].

For the forecasts generated by the equation (7.4.6) the root mean square error is 1,990 million drs, while the root mean percentage is 3.80%.

7.5 Receipts and Payments of the Invisible Account

The rest of the items of Greece's international transactions, as given in the national accounts, have been grouped in the following categories. On the receipts side into (i) expenditure of non-residents (ENR), (ii) receipts of transport and other services (RTOS), (iii) income receipts (IRV), and (iv) current transfers from the rest of the world (TRV). On the payments side there are four corresponding categories: (i) expenditure of residents abroad (ERA), (ii) payments of transport and other services (PTOS), (iii) income payments (IRV) and (iv) current transfers to the rest of the world (TPV).

It can be seen from the Table (7.1 in Appendix 1) that these items are very important in determining the balance of the country's international transactions. Thus, a modest attempt has been made to estimate some equations, which could explain the changes of these broad categories of transactions. The analysis is not very detailed and the construction of a relatively elaborate model was avoided, as this could lead to the inclusion of variables which either would present serious data problems or be difficult if not impossible to quantify (for example, changes in fashion, world and political climate etc.). Instead, simple linear or log linear functions were estimated, in an attempt to identify the influence of some broadly defined main factors causing fluctuations in these items.

The equations for the income and transfers receipts and payments are estimated in value terms. Those for the rest items were estimated in real terms. For the latter case, the implicit deflators for the export (PXS) and the import (PMS) of services were constructed. For this purpose, total imports and exports of goods at constant and current prices were substracted from the figures of the total imports and exports of goods and services combined (as given in the OECD tables), in order to arrive at the corresponding figures of important exports of services at current and constant prices. From these figures the corresponding deflator for imports and exports were calculated. Though these deflators may not be satisfactory for all diverse items included in the services, the volume figures for these categories were used, as this is considered more appropriate.

Expenditure of non Residents

It can be seen from the Table (7.1 Appendix 1) that the expenditure of non residents is a significant part of foreign exchange earnings. It covers all forms of expenditure, whether non residents visit the country as tourists or for business or any other purpose. As there is no breakdown of the non residents expenditure on this line, it was assumed that the same factors influence all types of non residents expenditure.

The main factors postulated to explain the tourist expenditure are the level of real incomes abroad and the prevailing prices in the country, relative to prices in other countries[17]. The world exports, delfated by the unit value of world exports (both expressed in USA dollars) was used as income variable. A proper procedure would have been to construct a weighted average of the disposable income of the tourists' countries of origin, weighted by their expenditure in Greece. To avoid the problems associated with the increase in the number of exogenous variables, relative to the limited number of observations, it has been decided to use the world exports as a proxy.

The relative price index ($\frac{PG}{PT_1}$) indicates relative changes between prices in Greece and prices in the country of origin. Due to the lack of adequate data for the price indices of travel services, the consumer price indices were used instead. PG is Greece's consumer price index, expressed in USA dollars. PT_1 is a weighted average of consumer price indices (expressed in USA dollars) of the following countries: France, Italy, West Germany, Sweden, United Kingdom and United States of America. These countries were selected because tourists from them form the most numerous groups, comprising on average between 55-65% of the total annual number of tourists, during the sample period.

The expenditure of the tourists from each selected country in Greece should have been used as the weights in the PT_1 price index. Because of the lack of data, the percentage from each of them (out of the total of the six countries) has been used instead.

As competition in tourism from other Mediterranean countries would affect the relative price, the index $\frac{PC}{PT_2}$ was also used, in an attempt to capture these effects. The denominator of this price index

PT_2 is a weighted average (expressed in USA dollars) of the consumer price indices of the above mentioned six countries. The weight for each country is its percentage out of the total number of tourists from all six of them who have visited the competing countries. The competing countries have been selected in a rather ad hoc way. In addition to the obvious choice of Spain, France and Italy, which have a highly developed tourist industry, and after the exclusion of Yugoslavia, because of its different economic system, Morocco was also added, as it has shared a significant increase in the number of tourists, especially during the later period of the sample.

Thus, the numerator of the second relative price PC is a weighted average of the consumer price indices of the four competing countries, expressed in USA dollars. The weights of each country is its percentage out of the annual total number of visitors from the above mentioned six countries of tourist origin. A time trend was included in the estimated equations to capture the effect of long run factors, such as changes in tastes. The expenditure of non residents is then considered as exports of travel services(18). The following export function is specified:

7.5.1 $$ENR_t = a_o + a_1 WY_t + a_2 \frac{PG}{PT_1}t + a_3 \frac{PC}{PT_2}t + u_t$$

where ENR is the expenditure of non residents in million drs at constant 1970 prices, deflated by the above mentioned implicit deflator.

WY, the proxy for the income of the countries of tourists' origins, is the volume of world exports, expressed in USA dollars, at constant 1970 prices, deflated by the unit value index of world exports. As an increase in incomes could lead, ceteris paribus, to an increase in the demand for travel services, a positive sign is expected for the coefficient a_1.

$\frac{PG}{PT_1}$, the relative price included in the travel export function, is the ratio of Greece's consumer price index to the weighted average of consumer price indices of the main countries of tourist origin. Both indices are expressed in USA dollars, and the expected sign of the relative price term (a_2) in an exports function is negative.

$\frac{PC}{PT_2}$, the competitors' weighted average of consumer price indices relative to the weighted average of consumer prices indices of the same countries included in the price index PT_1. Both are expressed in US dollars and constructed as described above. According to the demand theory, an increase in competitors' price could lead, ceteris paribus, to an increase in the number of tourists coming to Greece, hence to their expenditure as well. Thus, a positive sign is expected for the coefficient a_3 of the relative price $\frac{PC}{PT_2}$.

u_t is the random error of the equation.

Tourist industry acts, at least partially, on the information available and on expectations at the time that plans for travel services (like package tours) are made. To account for this factor the equation (7.5.1) has been estimated with the independent variables lagged one year. Thus, the equation has been estimated, for the period 1954-1977, both in linear and log-linear form. The log-linear results were more satisfactory, regarding the goodness of fit and the rest of the summary statistics. From the equations estimated, those with the price variables lagged one year had a better fit and a lower standard error of estimate. When the lagged dependent variable was included, both its own and the coefficient of income variable were statistically insignificant. The exchange rate variable (ER) and the time trend were also insignificant. The dummy variable (D74), accounting for the oil price increase and its subsequent effects on travel, proved statistically significant. Finally, the following equation with the income variable lagged one year was selected, not only for its superior statistical performance (significance of coefficients, goodness of fit, standard error of estimate), but also because it takes into account the already mentioned fact that decisions are based on lagged information.

7.5.2

$$\ell nENR_t = \underset{(2.64)}{8.131} + \underset{(8.21)}{0.923}\ell nWY - \underset{(5.63)}{3.163}\ell n \frac{PG}{PT_1}{}_{t-1} + \underset{(1.80)}{0.844}\ell n \frac{PC}{PT_2}{}_{t-1} - \underset{(3.88)}{0.354}D74$$

$R^2 = 0.99$ $\bar{R}^2 = 0.98$ DW = 2.12 N.A. SEE = 0.0849

$Z_1(3) = 3.444$

The equation has a very high fit, measured by $\bar{R}^2$, and its coefficients are statistically significant at the 5% level. They exceed their standard errors many times, except for the coefficient of the competitors' relative price $(\frac{PC}{PT_2})$, which is significant in one tail test at the 5% level. To test for the parameters constancy outside the sample period, the Z_1 statistic was calculated; its value (3.444) is less than the critical one, 5.992 with two degrees of freedom. So, the null hypothesis is accepted.

A sample of the equations estimated for the expenditure of non residents is presented below:

$$\ell nENR_t = -\underset{(2.06)}{3.574} + \underset{(7.32)}{1.068}\ell nWY - \underset{(3.52)}{2.422}\ell n\frac{PG}{PT_1} + \underset{(0.97)}{0.51}\ell n\frac{PC}{PT_2} - \underset{(3.52)}{0.347}D74 - \underset{(0.64)}{0.248}\ell nER_t$$

$R^2 = 0.99 \qquad \bar{R}^2 = 0.98 \qquad DW = 1.92$ N.A. $\qquad SEE = 0.0886$

$$\ell nENR_t = -\underset{(1.36)}{2.082} + \underset{(7.63)}{0.967}\ell nWY_{t-1} - \underset{(5.14)}{3.034}\ell n\frac{PG}{PT_1} + \underset{(1.65)}{0.789}\ell n\frac{PC}{PT_2} - \underset{(3.90)}{0.375}D74 - \underset{(0.79)}{0.296}\ell nER_t$$

$R^2 = 0.99 \qquad \bar{R}^2 = 0.98 \qquad DW = 2.29$ INC. $\qquad SEE = 0.0858$

$$ENR_t = \underset{(2.39)}{17393.9} + \underset{(0.22)}{25.49}T - \underset{(2.45)}{152.284}\frac{PG}{PT_1} + \underset{(5.31)}{0.783}ENR_{t-1}$$

$R^2 = 0.95 \qquad \bar{R}^2 = 0.94 \qquad DW = 2.06$ N.A. $\qquad SEE = 1090.69$

$$\ell nENR_t = -\underset{(2.42)}{3.918} + \underset{(7.94)}{1.027}\ell nWY - \underset{(3.95)}{2.552}\ell n\frac{PG}{PT_1} + \underset{(1.10)}{0.564}\ell n\frac{PG}{PT_2} - \underset{(3.53)}{0.33}D74$$

$R^2 = 0.98 \qquad \bar{R}^2 = 0.98 \qquad DW = 1.87$ N.A. $\qquad SEE = 0.0871$

The selected equation (7.5.2) was re-estimated for a first order autocorrelation process $u_t = \rho u_{t-1} + \varepsilon_t$. As the result below show, the autocorrelation coefficient is statistically insignificant and its magnitude is less than its standard error, so that the hypothesis of first order autocorrelation in the residuals should be rejected.

$$\ell nENR_t = \underset{(3.20)}{9.707} + \underset{(8.16)}{0.906}\ell nWY - \underset{(6.15)}{3.34}\ell n \frac{PG}{PT_1}_{t-1}$$

$$+ \underset{(1.51)}{0.725}\ell n \frac{PC}{PT_2}_{t-1} - \underset{(3.99)}{0.365}D74 \qquad \rho = \underset{(0.71)}{-0.15}$$

$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 2.06$ N.A. $\qquad SEE = 0.08409$

The income elasticity of the equation (7.5.2) is slightly less than one (0.923), while, generally, expenditure classified as services is expected to be elastic. Thus, this value could suggest that world exports is probably not adequate as a proxy for the income of the countries of tourist origin. The expenditure of non residents is highly elastic with respect to the relative price $\frac{PG}{PT_1}$. The magnitude of the elasticity -3.163 is well in excess of one. The coefficient of the relative price variable $\frac{PC}{PT_2}$ that measures the elasticity with respect to changes in competitors' price is less than one, indicating that earnings from travel are inelastic with respect to changes in the price prevailing in competing countries. In apart from the obvious defects already mentioned in the construction of the relative price variable, this result could not be considered implausible. Changes in the competitors' prices, within certain limits, would probably have no strong effect in travellers' tastes and habits, and no dramatic changes in travelling patterns and preferences could be expected, at least in the short run.

Expenditure of residents abroad (ERA)

The expenditure of residents abroad could, in a way analogous with the expenditure of non-residents, be considered as import services. This expenditure of residents mainly depends on the level of real disposable income in Greece and on the ratio of Greece's consumer price index to the consumer price indices of the foreign countries visited by the country's residents. As data of the numbers of tourists or their expenditure abroad were not available, no relative price variable was included. Thus, the following equation was estimated to account for residents' expenditure abroad.

7.5.3 $$ERA_t = b_o + b_1DY + b_2T + u_t$$

where ERA is the expenditure of residents abroad at constant 1970 prices, deflated by the implicit deflator for import services (PMS), previously described.

DY is the real disposable income at constant 1970 prices, deflated by the consumers' price index.

T is a time trend included to account for long run factors, such as changes in tastesand increasing lengths of holiday periods.

u_t is the random error term.

Some equations were estimated using the consumers' expenditure on services (CS) as explanatory variable, instead of disposable income, as the former is more closely related to travel expenditure. Equations estimated in log linear form, while similar in the summary statistics with the linear function, in most cases have insignificant and with the wrong sign coefficients for disposable income or the consumption of services. The time trend was always statistically insignificant, except when the lagged income or consumption of services were used; thus, it was dropped. In some equations the lagged dependent variable was also included, but its coefficient turned out to be statistically insignificant, with a t value less than one. Thus, the finally selected equation relates real expenditure of residents' travel services to the real disposable income.

7.5.4 $$ERA_t = -\underset{(3.43)}{457.409} + \underset{(20.68)}{0.0128}DY_t$$

$$R^2 = 0.95 \qquad \bar{R}^2 = 0.95 \qquad DW = 1.60 \text{ N.A.} \qquad SEE = 276.83$$

$$Z_{1(2)} = 4.368$$

When the equation (7.5.4) was estimated by generalized least squares, the autocorrelation coefficient had a magnitude of 0.20 and was statistically insignificant ($t = 0.97$), confirming the absence of first order autocorrelation in the residuals. The above equation satisfies the standard statistical criteria. The coefficient of disposable income is statistically significant at the 5% level. At the same time, it performs satisfactorily outside the sample period. Forecasts were generated for the years 1978-1979 and the value 4.368 of Z_1 statistic with two degrees of freedom is inside the critical value 5.992. The cumulative forecasting absolute error is 813 million drs, while the root mean square forecasting error is 409 million drs and the root mean square percentage forecasting error is about 8.6%.

The elasticity of the expenditure of residents abroad, with respect to disposable income (calculated at the sample means) exceeds one (1.221). The equation, as it has already been mentioned, is mispecified by the omission of the price term; so the elasticity should be treated with caution.

The following is a sample of equations estimated for the expenditure of residents abroad.

$$ERA_t = -\underset{(2.59)}{413.139} + \underset{(3.16)}{0.01196}DY_t + \underset{(0.22)}{11.71}T$$

$R^2 = 0.95$ $\bar{R}^2 = 0.94$ DW = 1.60 N.A. SEE = 289.93

$$ERA_t = -\underset{(1.98)}{579.53} + \underset{(10.31)}{0.0501}CS_t \qquad \rho = \underset{(2.09)}{0.40}$$

$R^2 = 0.84$ $\bar{R}^2 = 0.83$ DW = 2.07 N.A. SEE = 318.76

$$ERA_t = -\underset{(1.88)}{423.41} + \underset{(2.13)}{0.0295}CS + \underset{(1.64)}{73.25}T$$

$R^2 = 0.94$ $\bar{R}^2 = 0.93$ DW = 1.39 INC. SEE = 323.14

Receipts and Payments from Transport and other Services

For both receipts and payments from transport and other services, it was assumed that the non transport items are subject to influences from the same factors incluencing transports. Both were related by a simple linear or log linear function to an activity variable. For the receipts from transport and other services (RTOS) the basic activity variable was the volume of world exports of goods (WY′), expressed in USA dollars at constant 1970 prices. The volume of world exports was statistically significant and the estimated equation explained 86% of the variance. In an attempt to disentangle the separate effects of Greece's export demand from that of the rest of the world, the volume of Greece's export of goods (XG) was also included in the equation. But the coefficient of Greece's exports of goods variable was statistically insignificant and had a negative sign. The dummy variable (D74) was statistically insignificant and was dropped from the function. Thus, the finally selected equation is:

7.5.5 $$RTOS_t = -\underset{(0.28)}{80.518} + \underset{(11.92)}{0.0137}WY$$

$$R^2 = 0.87 \qquad \bar{R}^2 = 0.86 \qquad DW = 1.65 \text{ N.A.} \qquad SEE = 613.89$$

$$Z_1(2) = 1.358$$

where RTOS is the receipts of transport and other services at constant 1970 prices, deflated by the implicit deflator of export of services (PXS) WY is the volume of world exports deflated by the unit value of world exports.

The elasticity of transport and other services receipts with respect to changes in the volume of world exports (calculated at the sample mean) just exceeds one (1.024) and it implies a constant share of the world trade. Thus an increase in the world trade could not be expected to generate substantially higher receipts from export of services. The equation (7.5.5) performed satisfactorily outside the sample period. The value of the Z_1 statistic with two degrees of freedom (forecasts generated for the period 1978-1979) is 1.358, inside the critical value of 5.992, while the root mean square forecasting error is 506 million drs, the root mean square percentage forecasting error is 6.90% and the cumulative forecasting absolute error is 784 million drs.

There is no significant first order autocorrelation in the residuals, as the autocorrelation coefficient is statistically insignificant and the value of the t test statistic is less than one. This result is reported below, together with some other equations estimated for the receipts of transport and other services.

$$\underset{}{RTOS_t} = \underset{(0.08)}{29.654} + \underset{(9.59)}{0.0133WY} \qquad \rho = \underset{(0.72)}{0.15}$$

$$R^2 = 0.81 \qquad \bar{R}^2 = 0.80 \qquad DW = 1.98 \text{ N.A.} \qquad SEE = 613.89$$

$$RTOS_t = -\underset{(1.08)}{461.408} + \underset{(4.00)}{0.0193WY} - \underset{(1.18)}{0.0507XG}$$

$$R^2 = 0.87 \qquad \bar{R}^2 = 0.86 \qquad DW = 1.84 \text{ N.A.} \qquad SEE = 608.19$$

$$RTOS = \underset{(3.75)}{1023.34} + \underset{(8.80)}{0.115XG}$$

$$R^2 = 0.78 \qquad \bar{R}^2 = 0.77 \qquad DW = 0.98 \text{ POS.} \qquad SEE = 788.91$$

$$RTOS = \underset{(2.8)}{1364.01} + \underset{(4.77)}{0.0992XG} \qquad \rho = \underset{(2.76)}{0.50}$$

For the payments from transports and other services, the sum of Greece's volume of imports and exports of goods was used in the estimated equation as the activity variable. The dummy variable (D74), when introduced, was statistically insignificant and the finally selected equation in the log-linear form is the following:

7.5.6 $$\ell n PTOS_t = -\underset{(9.53)}{9.689} + \underset{(10.27)}{1.641}\ell n MXG$$

$$R^2 = 0.93 \qquad \bar{R}^2 = 0.93 \qquad DW = 1.56 \text{ N.A.} \qquad SEE = 0.3015$$

$$Z_1(2) = 0.148$$

where PTOS is payments for transport and other services at constant 1970 prices, deflated by the implicit deflator of import of services (PMS) and MXG is the sum of Greece's volume of imports and exports of goods, deflated by the unit value indices of imports and exports of goods respectively.

This equation was re-estimated by generalised least squares. The results below confirm the absence of first order autocorrelation in the residuals, as the autocorrelation coefficient was statistically insignificant ($t = 0.72$).

$$\ell n PTOS = -\underset{(7.47)}{8.912} + \underset{(14.17)}{1.571}\ell n MXG \qquad \rho = \underset{(0.72)}{0.15}$$

$$R^2 = 0.90 \qquad \bar{R}^2 = 0.90 \qquad DW = 2.16 \text{ N.A.} \qquad SEE = 0.2816$$

The forecasting ability of the equation (7.5.6) is quite satisfactory. The value of the $Z_1(k)$ statistic with two degrees of freedom (forecasts for 1978-79) is well inside the critical value (5.992). The root mean square forecasting error is 1.3 billion drs. The root mean square percentage forecasting error is about 8%, while the cumulative forecasting error is 2.5 billion drs.

Income and Transfer Receipts and Payments

The Table (7.1 in Appendix 1) shows the importance of income and transfers categories of the country's international transactions in reducing the deficit in the balance of payments and the subsequent need for credits.

No attempt has been made to model these categories in detail, because of the different items included in them and the difficulty in getting appropriate variables to adequately explain their changes. Thus, the main explanatory variables employed were those already used in the model, which could reflect the main trend of the economic activity in the country and abroad.

For the income receipts from the rest of the world category, the following equation was finally selected:

7.5.7 $$IRV = \underset{(7.60)}{-\ 26696.9} + \underset{(24.48)}{0.03308WY} + \underset{(2.09)}{81.913T} + \underset{(7.03)}{825.305ER_t}$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 1.26 \text{ INC.} \qquad SEE = 635.47$$

$$Z_{I(3)} = 157.799$$

where IRV is income receipts from the rest of the world in value.

WY is the volume of world exports, expressed in USA dollars, used as a proxy for the economic activity abroad.

T is the time trend.

ER is the exchange rate (drachmae per US dollars).

The goodness of fit of the equation is very high and the coefficients have the expected signs and are statistically significant at the 5% level. As the Durbin-Watson statistic is in the inconclusive region, the equation was re-estimated for a first order autocorrelation. The autocorrelation coefficient (ρ) of a magnitude 0.35 was statistically insignificant ($t = 1.79$) and thus the equation (7.5.7) was retained in the model although the value of the DW statistic casts doubts on the absence of autocorrelation from the residuals. The null hypothesis of forecasting accuracy was rejected, as the value 157.999 of the Z_1 statistic with three degrees of freedom (forecasts over the period 1978-80) is far in excess of the critical value of 7.817. At the same time, the root mean square percentage forecasting error is quite on the low side with a figure 6.16%; the cumulative absolute forecasting error is slightly over 11 billion drs and the root mean square error is 4.6 billion drs.

For the category of the income payments (IPV) to the rest of the world the value of GNP was considered as a suitable variable to account for the economic activity in the country. The equation which included the time trend as well, produced satisfactory results. As the national account of the country show that the largest part of income payments to the rest of the world involves mainly property and entrepreneurial incomes, the GNP was replaced by the non wage income variable. The results were equally satisfactory. The $\bar{R}^2$ was equally high and the standard error of estimate decreased considerably from 314.3 to 252.02. As the Durbin-Watson statistic was in the inconclusive region, the equation was re-estimated by generalised least squares. The results are presented below

7.5.8 $$IPV = -\underset{(12.61)}{1052.04} + \underset{(43.87)}{0.0309}NWYV_t - \underset{(6.54)}{76.9008}T \qquad \rho = \underset{(2.09)}{-0.40}$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 2.10 \text{ N.A.} \qquad SEE = 237.92$$

$$Z_1(3) = 99.217$$

The equation has a very good fit and the value of the Durbin-Watson statistic points to the absence of first order autocorrelation in the residuals. All variables are statistically significant at the 5% level. Thus, the above function was retained in the model. The value of the Z_1 statistic, 99.217 (critical value 7.815) with three degrees of freedom shows that the null hypothesis for constancy of the parameters outside the sample period cannot be accepted. The value of the root mean square percentage forecasting error 6.3% is not very large. The cumulative forecasting absolute error is around 2.9 billion drs, while the root mean square forecasting error is 1.4 billion drs. The transfer receipts in value (TRV) from the rest of the world, which are mainly transfers to households, were related to the volume of world exports of goods (WY) used as a proxy for economic activity abroad.

In addition, the exchange rate, the dummy variable (D74) and the number of emigrants were also tried, but all the three were statistically insignificant. Thus, the following linear equation, including only the volume of world exports of goods as explanatory variable, was considered:

$$TRV_t = \underset{(0.63)}{366.382} + \underset{(23.00)}{0.0327WY}$$

$R^2 = 0.96$ $\quad \bar{R}^2 = 0.96$ $\quad DW = 1.03$ POS. $\quad SEE = 1928.25$

As the value of the Durbin-Watson statistic confirms the presence of first autocorrelation in the residuals, the above equation was re-estimated by the procedure of generalised least squares. The results are as follows:

7.5.9 $\quad TRV_t = \underset{(1.92)}{8997.48} + \underset{(4.57)}{0.02098WY} \qquad \underset{(9.90)}{\rho = 0.90}$

$R^2 = 0.50 \qquad \bar{R}^2 = 0.48 \qquad DW = 1.79$ N.A. $\qquad SEE = 1670.63$

$Z_1(3) = 6.923$

Because of the large magnitude of the autocorrelation coefficient ($\rho = 0.90$) the above equation was estimated as almost in a first differences form and it therefore had a low value for R^2. The standard error of estimate of the equation was improved. The value of the Durbin-Watson statistic indicates the absence of autocorrelation in the residuals.

The equation performs satisfactorily as the value 6.923 of the Z_1 statistic, with three degrees of freedom (forecasts for the period 1978-1980) is less than the critical one (7.815); the root mean square percentage forecasting error is around 5.70%, the root mean square forecasting error is 2.5 billion drs and the cumulative forecasting error is around 6 billion drs.

Despite the attempts made, no satisfactory equation was found for the transfer payments in value (TPV) to the rest of the world which consists almost entirely from Government transfers to meet international obligations. Thus, a logarithmic trend was retained in the model, to account for the transfer payments to the rest of the world:

7.5.10 $\quad \ell nTPV = \underset{(10.36)}{2.8205} + \underset{(8.33)}{0.158T}$

$R^2 = 0.75 \qquad \bar{R}^2 = 0.74 \qquad DW = 0.74$ POS. $\qquad SEE = 0.6458$

The forecasts generated with the trend equation (7.5.10) for the period 1978-1980 were also unsatisfactory, as the value of 46.6% of the root mean square percentage forecasting error indicates.

Summarily, the selected equations for the invisibles account and the income and transfer items of Greece's international transactions are presented below with the summary statistics and the figures for the root mean square percentage forecasting error (RMSPE):

(a) Expenditure for Non Residents (ENR)

7.5.2

$$\ell nENR_t = \underset{(2.64)}{8.131} + \underset{(8.21)}{0.923}\ell nWY - \underset{(5.63)}{3.163}\ell n \frac{PG}{PT_1}{}_{t-1} + \underset{(1.80)}{0.844}\ell n \frac{PC}{PT_2}{}_{t-1} - \underset{(3.88)}{0.354}D74$$

$R^2 = 0.99$ $\bar{R}^2 = 0.98$ DW = 2.12 N.A. SEE = 0.0849

RMSP = 10.52% $Z_1(2) = 3.444$

(b) Expenditure of Residents Abroad (ERA)

7.5.4

$$ERA_t = - \underset{(3.43)}{457.409} + \underset{(20.68)}{0.0128}DY_t$$

$R^2 = 0.95$ $\bar{R}^2 = 0.95$ DW = 1.60 N.A. SEE = 276.83

RMSP = 8.63% $Z_1(2) = 4.368$

(c) Receipts from Transport and Other Services (RTOS)

7.5.5

$$RTOS_t = - \underset{(0.28)}{80.518} + \underset{(11.92)}{0.0137}WY$$

$R^2 = 0.87$ $\bar{R}^2 = 0.86$ DW = 1.65 N.A. SEE = 613.89

RMSPE = 6.91% $Z_1(2) = 1.358$

(d) Payments for Transport and Other Services (PTOS)

7.5.6 $\ell nPTOS_t = -\underset{(9.53)}{9.689} + \underset{(10.27)}{1.641}\ell nMXG_t$

$R^2 = 0.93$ $\bar{R}^2 = 0.93$ DW = 1.56 N.A. SEE = 0.3015

RMSPE = 8.07% $Z_1(2) = 0.148$

(e) Income Receipts from the Rest of the World in Value (IRV)

7.5.7 $IRV_t = -\underset{(7.60)}{26696.9} + \underset{(24.48)}{0.03308}WY + \underset{(2.09)}{81.913}T + \underset{(7.03)}{825.305}ER_t$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.26 INC. SEE = 635.47

RMSPE = 6.16% $Z_1(3) = 157.799$

(f) Income Payments to the Rest of the World in Value (IPV)

7.5.8 $IPV_t = -\underset{(12.61)}{1052.04} + \underset{(43.87)}{0.0309}NWYV_t - \underset{(6.54)}{76.9008}T$ $\rho = -\underset{(2.09)}{0.40}$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.10 N.A. SEE = 237.92

RMSPE = 6.32% $Z_1(3) = 99.217$

(g) Transfers from the Rest of the World in Value (TRV)

7.5.9 $TRV_t = \underset{(1.92)}{8997.48} + \underset{(4.57)}{0.0209.8}WY$ $\rho = \underset{(9.90)}{0.90}$

$R^2 = 0.50$ $\bar{R}^2 = 0.48$ DW = 1.79 N.A. SEE = 1670.63

RMSPE = 5.73% $Z_1(3) = 6.923$

(h) Transfers to the Rest of the World in Value (TPV)

7.5.10 $$\ell nTPV = \underset{(10.36)}{2.8205} + \underset{(8.33)}{0.158}T$$

$R^2 = 0.75$ $\bar{R}^2 = 0.74$ DW = 0.74 POS. SEE = 0.6458

RMSPE = 46.6%

FOOTNOTES TO CHAPTER 7

1. D. Gowland, International Economics, 1983, p. 10.

2. T.S. Barker, "International Trade and Economic Growth: an Alternative to the Neoclassical Approach", Cambridge Journal of Economics, 1 (1977).

3. T.S. Barker, "Imports" in the Economic Structure and Policy with Application to the British Economy, ed. T.S. Barker, 1976.

4. T. Murray and P.J. Ginman, "An Empirical Examination of the Traditional Aggregate Import Demand Model", Review of Economics and Statistics, 58 (1976).

5. E.E. Leamer and R.M. Stern, Quantitative International Economics, 1970.

6. Leamer and Stern. op. cit.

7. Leamer and Stern. op. cit. Also, G. Yadav "A Quarterly Model of the Canadian Demand for Imports 1956-1972", Canadian Journal of Economics, 8 (1975).

8. J.D. Whitley, "Imports of Finished Manufactures: the Effect of Prices, Demand and Capacity", Manchester School, 47-48 (1979-1980).

9. Leamer and Stern. op. cit.

10. The unit value indices which are regularly used in import - export studies, present serious problems. Unit value indices are values per unit of quantity calculated on a detailed import - export classified basis. That is for any class of commodities of imports (exports), the value of imports (exports) is divided by the unweighted sum of the quantities imported (exported). Consequently the unit value index is an unweighted average of these unit values.
Because of lack of close specification of the items entering in each class of commodities, a change in a unit value index may be the result of changes in the composition of any commodity class, independently of any change in the prices of the commodities. Hence, the unit value index can change because of shifts in the quality or variety of the items included in any class, while prices may have not fluctuated at all. Apart from that, unit value of indices of exports are calculated, for a country's exports to all regions, on F.O.B. basis, and thus they are not affected by differences in prices to buyers in different regions, which arise from differences in transport

and distribution costs and tariffs. (Leamer and Stern, op. cit. Also H.B. Junz and R.R. Rhomberg, "Prices and Export Performance of Industrial Countries 1953-1963", IMF Staff Papers, 12 (1965) and G.C. Hufbaure and J.P. O'Neil, "Unit Value Indices of US Machinery Exports", Journal of International Economics, 2 (1972)).

11. R.E. Caves and R.W. Jones, World Trade and Payments, 1977; B. Sodersten, International Economics, 1980. Also H.S. Hauthakker and S.P. Magee, "Income and Price Elasticities in World Trade", Review of Economics and Statistics, 51 (1969); Yadav op. cit.; M.E. Kreinin, "Disaggregated Import Demand Functions - Further Results", Southern Economic Journal, 40 (1973-75); M. Goldstein and M.S. Khan, "The Supply and Demand for Exports: A Simultaneous Approach", Review of Economics and Statistics, 60 (1978).

12. Hauthakker and Magee, op. cit; Leamer and Stern, op. cit.

13. Leamer and Stern, op. cit., ch 7; B. Balassa, "Export Composition and Export Performance in the Industrial Countries 1953-1971", Review of Economics and Statistics, 61 (1979).

14. Murray and Ginman, op. cit.

15. Long run is defined as sufficiently long period for demand to be fully adjusted to changes in prices and incomes (Yadav, op. cit.).

16. Goldstein and Khan, op. cit.

17. P.Phillips, "A Forecasting Model for the U.K. Invisible Account", National Institute Economic Review, 63-70 (1973-74).

18. J.R. Artus, "The Effect of Revaluation on the Foreign Travel Balance of Germany", IMF Staff Papers, 17 (1970).

8. WAGES AND PRICES

8.1 Because of the importance of prices in the functioning of the economic system, various theories have been expounded to explain the main factors which determine them.

These theories try to explain not only the general price level but also its fluctuations and especially the inflation process, that is the persistent tendency of the general price level to rise[1], which has characterised many contemporary periods.

Basically the theories which try to explain inflation can be grouped into two categories: the demand pull and the cost push theories, and a brief summary of them will be given below:

Demand Pull Theories

8.2 The Quantity Theory of Money

According to the quantity theory of money, the price level (P) is determined by the intersection of the demand for and supply of money functions. Hence variations in the price level is the mechanism which bringsinto equilibrium the desired with the actual real cash balances. That is, the demand for money equals the money supply, both expressed in real terms.

Starting from an initial equilibrium in which $\frac{M^s}{P} = \frac{M^d}{P}$ (where M^s is the money supply and M^d is the demand for money), the actual real cash balances will exceed its desired rate when money supply is increased. Thus people will try to bring their real balances back into equilibrium by spending on goods and services the amount which exceeds their desired real cash balances.

But, according to this theory, as real output is determined in the real sector of the economy and money changes cannot have any effect, the increase in the money supply will result in increasing the price level until equilibrium between $\frac{M^s}{P}$ and $\frac{M^d}{P}$ will be established.

Another means of transmission is provided by the Marshallian interest rate mechanism(2). According to this, there is an inverse relation between the interest rate and the nominal money supply. An increase in the money supply will lower the interest rate and could lead to an increase in the desired investment and possibly consumption. But as the output of the economy is assumed to be at the full employment level, any increase in the desired level of investment and consumption will lead to an increase in all prices, including the price of labour, that is wages.

8.3 The Inflationary Gap

The Keynesian explanation of increases in the price level is based on the concept of excessive aggregate demand and its effect: the inflationary gap.

Assuming, for simplicity, a closed economy, the inflationary gap exists when real aggregate planned expenditure of consumers, investors and the government exceeds the total real output at full employment. This implies that the ex post real expenditure is less than its ex ante value (that is aggregate demand exceeds full employment output) and consequently prices will rise.

8.4 Wage Inflation

Demand pull theories recognize that inflation is caused by the excess demand in the product and labour markets. The following hypothesis is trying to explain inflation in the labour market, that is wage inflation.

In his article published in 1958 A.W. Phillips investigated the relation between the rate of change in money wages and the unemployment rate, the latter taken as a proxy of excess demand in the labour market. He obtained a non-linear and negative relation, known as the Phillips curve, of the form:

8.4.1 $\hat{W} + a = bU^{c}$

Where $\dot{W}$ is changes in the wage rate and U the rate of unemployment.

The Phillips curve indicates the magnitute of changes in the wage rate at different rates of unemployment.

The above work has been strongly criticised on statistical grounds and for the weakness of its theoretical foundations.

In an important article R.G. Lipsey(3) tried to correct the statistical aspects of Phillips curve and give a vigorous theoretical explanation to the wage rate - unemployment relation.

He examined the relation between changes in the wage rate and the unemployment rate in a single market and then proceeded to examine the relationship in the aggregate macro-level.

Lipsey's analysis is conducted in a situation of disequilibrium in the labour market. He states that if there exists an excess demand in the labour market then, as in every market, wage rates will rise, while they will fall when excess supply is prevalent.

He then postulates that the speed of changes in wages depends on the excess of demand over the labour supply(4), that is

8.4.2 $$\dot{W} = f\left(\frac{L^d - L^s}{L^s}\right)$$

where $\dot{W}$ the wage change (the time derivative of wages) L^d the demand for labour and L^s the labour supply.

If a linear relation is assumed, for simplicity, the above relation takes the form:

8.4.3 $$\dot{W} = a\left(\frac{L^d - L^s}{L^s}\right)$$ where a is a constant.

But the excess demand for labour is not observable. Thus, the necessity of a suitable proxy variable arises. For the case of the excess demand for labour, the unemployment rate is used to closely approximate it.

Consequently the change in the wage rate in each labour market is a function of the unemployment rate prevailing in that market, that is

8.4.4 $$\dot{W} = f(U)$$

As Lipsey has argued, the main part of this function will be non-linear and hence it could have been described by a functional form, such as

8.4.5 $$\dot{W} = a_o + a_1 U^{-a_2}$$

Proceeding from the micro-relations to the aggregate macro-function, he suggested that at the macro level not only the unemployment rate but also its distribution in the submarkets of the economy will determine the change in the wage rates. That is, the observed macro-relation is an average of the micro-levels and will be above them when there is a degree of inequality in the distribution of unemployment combined with excess demand in at least one market.

In the estimated equations Phillips has included the rate of change of the cost of living index, on the assumption that cost of living adjustments affect changes in money wage rates, with a threshold effect. Lipsey tested and subsequently rejected this hypothesis, but suggested[(5)] that there probably exists a simple feedback relation from changes in the cost of living index to changes in the money wage rates.

8.5 The Natural Rate of Unemployment Hypothesis

Because of market frictions and structural changes, unemployment will always be present in the economy. Declining industries will shed labour force, whose skills may not be suitable for the needs of the growing sectors and the situation could deteriorate by inadequate mobility of the labour force. Furthermore technological improvements and innovations may make redundant some of the previously employed. Finally, there are people in the process of changing jobs and time is required until a new one is found.

Thus, there will be some unemployment at any point of time, even when the economy is in general equilibrium, that is when all markets are cleared, or to put it in another way, when all expectations are realized(6).

This equilibrium rate of unemployment is called the natural rate of unemployment, and is determined by such factors as market frictions, real incomes, tax rates. Thus the natural rate is not constant but changes with changes in these real factors, so that nominal forces such as anticipated inflation cannot have any permanent or significant effects on it.

Hence by generalisation to all prices and not only to wages, this hypothesis implies that there is no long run trade off between inflation and unemployment as the Phillips curve indicates. Suppose that the unemployment in the economy is at its natural rate and without inflation. Assuming that by their policies the monetary authorities increase the rate of inflation, then, according to the Phillips curve, the unemployment will decrease.

However according to M. Friedman, one of the main exponents of the natural rate hypothesis, as inflation will start rising people will adjust their expectations accordingly, causing an upward shift in the Phillips curve(7). Finally when inflation settles to its new level, and expected inflation has adjusted to that level, unemployment will be back to its natural rate and the economy will be on a new short run Phillips curve with higher inflation.

So the long run Phillips curve will be vertical at the point of the natural rate of unemployment. As a consequence of this analysis, if a rise in the rate of inflation reduces temporarily the unemployment rate, a continuous increase in inflation rate is required in order to keep unemployment below its natural rate. This suggestion constitutes the accelerationist hypothesis.

The natural rate hypothesis can be expressed in the formula:

8.5.1 $$\frac{\Delta P}{P} = f(U) + b\left(\frac{\Delta P}{P}\right)^e$$

Where $\frac{\Delta P}{P}$ is the rate of change of prices, $f(U)$ is a function of the unemployment rate and $\left(\frac{\Delta P}{P}\right)^e$ the expected rate of change in prices.

When this equation is estimated the magnitude of b, the coefficient of price expectations, is examined. If $b = 1$ the acceleration hypothesis is accepted while if $b < 1$ this hypothesis is rejected and consequently the existence of a long run trade off between unemployment and inflation is corroborated.

Rearranging the above equation (8.5.1) and assuming that the accelerationist hypothesis holds ($b = 1$) we get:

8.5.2 $$\left(\frac{\Delta P}{P}\right) - \left(\frac{\Delta P}{P}\right)^e = f(U)$$

The inflation rate consequently consists of a full anticipated part $\left(\frac{\Delta P}{P}\right)^e$ and the unanticipated part $\frac{\Delta P}{P} - \left(\frac{\Delta P}{P}\right)^e$. Hence the above equation (8.5.2) states that the unanticipated inflation changes with the unemployment rate[7]. Consequently inflation will be fully anticipated $\left(\frac{\Delta P}{P} = \left(\frac{\Delta P}{P}\right)^e\right)$ when unemployment is at its natural rate that is when $\frac{\Delta P}{P} - \left(\frac{\Delta P}{P}\right)^e = 0$. The natural rate may be then found by evaluating the roots of the equation $f(U) = 0$.

8.6 Rational Expectations

The hypothesis that only unanticipated inflation and no systematic policy will have any effect on unemployment or output was emphasized in a consistent way by the theory of rational expectations. It is based on two propositions that

a) economic agents form their expectations on all available information and

b) prices are perfectly flexible and consequently all markets clear in the short run(8).

As expectations are based on all available information a continuous bias in expected inflation cannot be reconciled with the assumed rationality of economic agents. Such an outcome, of consistent bias in expected inflation, can be derived from an adaptive expectations mechanism in a period of accelerating inflation. In this case if $\frac{\Delta P}{P}_t > \frac{\Delta P}{P}_{t-1}$ for all t, the expected inflation rate will lag behind actual inflation, implying that economic agents are making consistently wrong forecasts and do not learn from past experience(9). Thus rational maximizing agents should have an expectations mechanism which could generate unbiased forecasts, that is forecasts free from any systematic error. This implies that rational maximizing agents, in a situation of equilibrium market clearing, will use any information available to them and so they will generate expectations for any variable conditionally upon that information. Hence, expectations of any variable should be unbiased estimates of the actual stochastic process which generates these variables. That is both expectations and the variable about which expectations are formed should have the same mean and any deviation of expectations from the mean of the variable in question should be random. In that sense expectations are rational.

The theory of rational expectations argues that policy meausres will be ineffective in influencing the path of output and hence of unemployment.

The above issues raised by the rational expectations hypothesis can be demonstrated by the use of a simple model often employed in the relevant literature[10]:

8.6.1 $\ell nY_t = a_o + a_1 [r_t - E_{t-1} (\ell nP_{t+1} - \ell nP_t)] + v_{1t} \quad a_1<0$

8.6.2 $\ell nM_t - \ell np_t = b_o + b_1Y_t + b_2r_t + v_{2t} \quad b_2<0,\ b_1>0$

8.6.3 $\ell nY_t = c_o + c_1 (\ell np_t - E_{t-1}\ell np_t) + c_2\ell nY_{t-1} + v_{3t} \quad c_1>0 \quad 0\leq c_2<1$

Equation (8.6.1) is a type of an IS expenditure function which represents the quantity of output (Y_t) demanded for consumption and investment as a function of the real interest rate.

The LM equation (8.6.2) describes the demand for real balances ($\frac{M}{P}$) as a function of real output and the nominal interest rate (r_t).

The stimulus to the aggregate supply equation (8.6.3), in line with the accelerationist hypothesis is provided by the unexpected component of inflation ($\ell nP_t - E_{t-1}\ell nP_t$).

The error terms v_{1t}, v_{2t} and v_{3t} represent unsystematic forces affecting the economy and assumed to have zero means and constant variances and to be independent of the past values of the error terms and all the variables in the model.

The term $E_{t-1}P_{t+i}$ is the mathematical expectation of the variable P_{t+i} $(i = 0, 1, \ldots)$ which is computed by using the equations of the model and the values of the variables up to period t-1.

In the above model a policy equation is usually added to describe the proces by which a policy concerning the generation of the money supply is formed:

8.6.4 $$\ell n M_t = d_o + d_1 \ell n M_{t-1} + d_2 \ell n Y_{t-1} + v_{4t}$$

Equation (8.6.4) states that current money supply (M_t) responds with a feedback to money supply (M_{t-1}), previous output (Y_{t-1}) and a random disturbance (v_{4t}).

Eliminating r_t from equation (8.6.1) and (8.6.2) gives:

8.6.5 $$\ell n Y_t = e_o + e_1 (\ell n M_t - \ell n P_t) + e_2 E_{t-1}(\ell n P_{t+1} - \ell n P_t) + w_t$$

where $e_o = \dfrac{a_o b_2 - a_1 b_1}{a_1 b_1 + b_2}$, $e_1 = \dfrac{a_1}{a_1 b_1 + b_2}$, $e_2 \sqrt{\dfrac{a_1 b_2}{a_1 b_1 + b_2}}$,

$$w_t = \frac{b_2}{a_1 b_1 + b_2} v_{1t} - \sqrt{\frac{a_1}{a_1 b_1 + b_2}} v_{2t}$$

Substituting for $\ell n Y_t$ from the equation (8.6.3) into (8.6.5) and solving for $\ell n P_t$ we get

8.6.6 $$\ell n P_t = \frac{e_o - c_o}{c_1 + e_1} + \frac{c_1}{c_1 + e_1} \ell n M_t - \frac{c_2}{c_1 + e_1} \ell n Y_{t-1}$$

$$+ \frac{c_1}{c_1 + e_1} E_{t-1} \ell n P_t + \frac{c_2}{c_1 + e_1} E_{t-1} (\ell n P_{t+1} - \ell n P_t)$$

$$+ \frac{1}{c_1 + e_1} (w_t - v_{3t})$$

Applying the operator E_{t-1} to equation (8.6.6) we derive the equation for $E_{t-1}\ell nP_t$ as

8.6.7 $$E_{t-1}\ell nP_t = \frac{e_o - c_o}{c_1 + e_1} + \frac{e_1}{c_1 + e_1} E_{t-1}\ell nM_t - \frac{c_2}{c_1 + e_1} \ell nY_{t-1}$$
$$+ \frac{c_1}{c_1 + e_1} E_{t-1}\ell nP_t + \frac{e_2}{c_1 + e_1} E_{t-1} (\ell nP_{t+1} - \ell nP_t)$$

Subtracting the equation (8.6.7) from (8.6.6) the equation (8.6.8) is obtained

8.6.8 $$\ell n P_t - E_{t-1}\ell n P_t = \frac{e_1}{c_1 + e_1} (\ell nM_t - E_{t-1}\ell nM_t)$$
$$+ \frac{1}{c_1 + e_1} (w_t - v_{3t})$$

Applying the operator E_{t-1} in the equation describing the monetary policy (8.6.4) we derive

8.6.9 $$E_{t-1}\ell nM_t = d_o + d_1\ell nM_{t-1} + d_2\ell nY_{t-1}$$

Inserting the equations (8.6.4) and (8.6.9) into (8.6.8) results in

8.6.10 $$\ell np_t - E_{t-1}\ell nP_t = \frac{e_1}{c_1 + e_1} v_{4t} + \frac{1}{c_1 + e_1} (w_t - v_{3t})$$

Finally substituting for $(\ell nP_t - E_{t-1}\ell nP_t)$ from equation (8.6.10) into the equation (8.6.3) the reduced form of the equation for output is derived

$$\ell nY_t = c_o + c_2 \ell nY_{t-1} + \frac{c_1 e_1}{c_1 + e_1} v_{4t} + \frac{c_1}{c_1 + e_1} w_t + \frac{e_1}{c_1 + e_1} v_{3t} \tag{8.6.11}$$

According to the reduced form equation (8.6.11) of the above model if expectations are formed rationally and money illusion is absent[11], the aggregate output supply will be affected only by random errors. Hence, policy will not have any systematic influence on output and consequently on unemployment.

8.7 E. Kuh's Productivity Theory of Wage Levels

In his article in 1967[12], E. Kuh has proposed a theory of the relation between the level of money wages and the average product of labour, expressed in value terms. By assuming a Cobb-Douglas production function, neutral technological change and an inelastic labour supply with respect to the money wage rate, he derives an expression of the equilbrium wage rate.

He postulates a production function of the form:

$$Q = A\ L^a K^b \tag{8.7.1}$$

with constant returns to scale that is a + b = 1 and where Q is the real total product, L the labour input and K stands for the capital input.

The marginal product of labour is

$$\frac{\partial Q}{\partial L} = a\ A\ L^{a-1} K^b \tag{8.7.2}$$

and the average product of labour is

8.7.3 $$\frac{Q}{L} = A\, L^{a-1} K^{b}$$

Thus by substituting (8.7.3) into (8.7.2) we get:

8.7.4 $$\frac{\partial Q}{\partial L} = a\, \frac{Q}{L}$$

So, the marginal product of labour is a constant multiple of the average labour product. In equilibrium the real wage rate equals the marginal product of labour:

8.7.5 $$\frac{W}{P} = \frac{\partial Q}{\partial L}$$ where W is the money wage and P the price level

Substituting (8.7.5) into (8.7.4) the following equation is derived

8.7.6 $$\frac{W}{P} = a\, \left(\frac{Q}{L}\right)$$

or $W = a\, \left(\frac{PQ}{L}\right)$

That is in equilibrium the wage level is a constant function of the average product of labour in value terms. Kuh also accepts the influence of the unemployment rate on wage changes, maintaining that the unemployment variable reflects the bargaining power of labour. Thus the equation generated is of the form

8.7.8 $$W = B \left(\frac{PQ}{L}\right)^{a_1} U^{-a_2}$$

He then argues that, in the long run, the main cause of changes in the money wages is changes in the value of the average product of labour and that unemployment will cause short run fluctuations around this long run trend.

8.8 Cost Push Inflation

Cost push inflation has been attributed to the pressures of the organised labour for increases in wage rates. In the theoretical framework of the cost push theories of inflation, it is postulated that the wage rate is not determined in the market by the interaction of supply of and demand for labour. That is, wages do not adjust fast to the level necessary for the labour market to clear.

Wages are administered and so they rise not only when there is an excess demand in the labour market as the demand pull inflation theories postulate.

Wages are the result of bargaining between unions and employers' organisations, which exercise a degree of monopoly power.

Thus, even when there is no excess demand for labour, wages may rise to reflect increases in the cost of living, because organised labour is able to extract increases by strikes or the threat of strikes. In other cases, wages increase in order to keep into line with increases given to the work force in other sectors, or because wages are tied up to productivity increases.

8.9 Optimal Long-Run Price Behaviour

A model of optimal long-run pricing behaviour has been elaborated by W.D. Nordhaus, based on the neoclassical economic theory(13).

It is assumed that the representative firm operates in a closed economy and faces a demand curve of the form

8.9.1 $$Q = BP^{-b_1} Y^{b_2}$$

where Q is output, P the selling price and Y income(14). The production function is of the Cobb-Douglas type with constant returns to scale and neutral technological change taking place smoothly at an exponentially

8.9.2 $$Q = A\,K^{a_1} L^{a_2} M^{(1-a_1-a_2)}\, e^{\gamma t}$$

K is capital services, L manhours and M raw materials. Abstracting from temporal dependencies the firm sets the price aiming at maximizing its profits (Π) in every period:

8.9.3 $$\Pi = PQ - C$$

and the cost (C) function is

8.9.4 $$C = qK + wL + \nu M$$

where q is the price of capital services, w the wage rate and ν the price of raw materials.

As economic theory states the firm has to equate the marginal revenue to its marginal cost in order to maximize its profits.

From the equation (8.9.1) the price is

8.9.5 $$P = B^{\frac{1}{b_1}} Y^{\frac{b_2}{b_1}} Q^{-\frac{1}{b_1}}$$

Thus the profit function by substituting from (8.9.5) and (8.9.4) becomes:

8.9.6 $$\Pi = B^{\frac{1}{b_1}} Y^{\frac{b_2}{b_1}} Q^{1-\frac{1}{b_1}} - qK - wL - \nu M$$

Substituting for Q from the production function (8.9.2) into (8.9.6) we have:

8.9.7 $$\Pi = B^{\frac{1}{b_1}} Y^{\frac{b_2}{b_1}} [AK^{a_1} L^{a_2} M^{(1-a_1-a_2)} e^{\gamma t}]^{(1-\frac{1}{b_1})} - qK - wL - \nu M$$

For maximization the first order derivatives of the above function with respect to all inputs should be set equal to zero.

8.9.8 $$\frac{\partial \Pi}{\partial L} = (1 - \frac{1}{b_1}) B^{\frac{1}{b_1}} Y^{\frac{b_2}{b_1}} [AK^{a_1} L^{a_2} M^{(1-a_1-a_2)} e^{\gamma t}]^{-\frac{1}{b_1}}$$

$$a_2 [AK^{a_1} \frac{L^{a_2}}{L} M^{(1-a_1-a_2)} e^{\gamma t}] - w = 0$$

$$\frac{\partial \Pi}{\partial K} = (1 - \frac{1}{b_1}) B^{\frac{1}{b_1}} Y^{\frac{b_2}{b_1}} [AK^{a_1} L^{a_2} M^{(1-a_1-a_2)} e^{\gamma t}]^{-\frac{1}{b_1}}$$

$$a_1 [A\frac{K^{a_1}}{K} L^{a_2} M^{(1-a_1-a_2)} e^{\gamma t}] - q = 0$$

$$\frac{\partial \Pi}{\partial M} = (1 - \frac{1}{b_1}) B^{\frac{1}{b_1}} Y^{\frac{b_2}{b_1}} [AK^{a_1} L^{a_2} M^{(1-a_1-a_2)} e^{\gamma t}]^{-\frac{1}{b_1}}$$

$$(1-a_1-a_2) [AK^{a_1} L^{a_2} \frac{M}{M}^{(1-a_1-a_2)} e^{\gamma t}] - \nu = 0$$

As the terms in brackets equal output Q, substituting from the production function (8.9.2) for Q the first order derivatives of the profit function become

$$w = a_2 (1 - \frac{1}{b_1}) B^{\frac{1}{b_1}} Y^{\frac{b_1}{b_2}} Q^{-\frac{1}{b_1}} \frac{Q}{L}$$

$$q = a_1 (1 - \frac{1}{b_1}) B^{\frac{1}{b_1}} Y^{\frac{b_1}{b_2}} Q^{-\frac{1}{b_1}} \frac{Q}{K}$$

$$\nu = (1-a_1-a_2) (1 - \frac{1}{b_1}) B^{\frac{1}{b_1}} Y^{\frac{b_1}{b_2}} Q^{-\frac{1}{b_1}} \frac{Q}{M}$$

Substituting the price P from equation (8.9.5) for the term $B^{\frac{1}{b_1}} Y^{\frac{b_1}{b_2}} Q^{-\frac{1}{b_1}}$, Q from the demand function (8.9.1) and solving the above equations for the inputs L, K and M we obtain

$$L = (1 - \frac{1}{b_1}) P^{1-b_1} B Y^{b_2} \frac{a_1}{w}$$

$$K = (1 - \frac{1}{b_1}) P^{1-b_1} B Y^{b_2} \frac{a_1}{q}$$

$$M = (1 - \frac{1}{b_1}) P^{1-b_1} B Y^{b_2} \frac{(1-a_1-a_2)}{\nu}$$

Substituting the above equations into the production function the following function is derived

$$Q = A\left[\left(1 - \frac{1}{b_1}\right) P^{1-b_1} B\, Y^{b_2}\right]^{a_1} \left(\frac{a_1}{q}\right)^{a_1} \left[\left(1- \frac{1}{b_1}\right) P^{1-b_1} B\, Y^{b_2}\right]^{a_2}$$

$$\left(\frac{a_2}{w}\right)^{a_2} \left[\left(1 - \frac{1}{b_1}\right) P^{1-b_1} B\, Y^{b_2}\right]^{(1-a_1-a_2)}$$

$$\left(\frac{1-a_1-a_2}{\nu}\right)^{(1-a_1-a_2)} e^{\gamma t}$$

or

8.9.9 $$Q = A\left(1 - \frac{1}{b_1}\right) P^{1-b_1} B\, Y^{b_2} \left(\frac{a_1}{q}\right)^{a_1} \left(\frac{a_2}{w}\right)^{a_2} \left(\frac{1-a_1-a_2}{\nu}\right)^{(1-a_1-a_2)} e^{\gamma t}$$

Substituting for Q from the demand function (8.9.1) into (8.9.9) and then solving the latter for the price variable P, we derive

8.9.10 $$P = A^{-1} \left(1 - \frac{1}{b_1}\right) a_1^{-a_1}\, a_2^{-a_2}\, (1-a_1-a_2)^{-(1-a_1-a_2)}$$

$$\frac{1}{q^{-a_1}}\, \frac{1}{w^{-a_2}}\, \frac{1}{\nu^{-(1-a_1-a_2)}}\, e^{-\gamma t}$$

setting $D = A^{-1} \left(1 - \frac{1}{b_1}\right) a_1^{-a_1}\, a_2^{-a_2}\, (1-a_1-a_2)^{-(1-a_1-a_2)}$

the long run price for profit maximization is

8.9.11 $$P = De^{-\gamma t} q^{a_1} w^{a_2} \nu^{(1-a_1-a_2)}$$

The above equation shows that the optimal long run price is based on factor costs and indicates that the cost of capital services should also be included in the price. The productivity effects on price (negative) are represented by the time trend due to the assumption of the model that technological change progress at a constant exponential rate and does not vary over the business cycle.

8.10 Mark Up Pricing

Generally, it is assumed that prices adjust to changes in unit costs. The basic model postulates that prices are influenced by various unit costs and that a fixed percentage mark up on costs is added to cover overheads and a profit margin. The unit labour cost is deflated usually by the average product of labour, and the basic mark up model, under the assumption that the share of profits in the value output is constant(15), has the following form:

8.10.1 $$P_t = a_o + a_1 W_t - a_2 \left(\frac{Q}{L}\right)_t + a_3 \, PM_t$$

All variables represent rates of change and P is prices W the money wage rate, $\frac{Q}{L}$ the average product of labour and PM the import prices.

A variant of this model uses the concept of normal cost pricing. That is, prices are based not on the actual costs but on the cost of a normal level of output. Prices will be adjusted when the cost of the normal level of output changes and not to changes in costs effected by short term factors.

As thelong run trend in the unit labour cost is determined by money wages and the long term trend in the average labour product, the price equation in this variant of the mark up mode will be:

8.10.2 $$P_t = b_o + b_1 \, ULCT_t + b_2 PM_t$$

where ULCT is the trend value of unit labour costs, which as it has been said above is the ratio of money wages to long term trend in average productivity $(\frac{W}{\bar{Q}})$, and thus an increase in money wages (W) will contribute to an increase in prices, while an increase in the long term trend of the average productivity $(\bar{Q})$ will have the opposite effect of lowering prices. Mark up models have been expanded by including other variables, such as the degree of capacity utilization to account for the influence of the excess demand on prices.

8.11 The Empirical Investigation of Wages and Prices for the Greek Economy

The importance of determining the factors that influence wages arises not only from the fact that wages and salaries are a large part of national income and hence highly significant for the magnitude and composition of national expenditure, but also from the fact that they constitute one of the main elements of prices.

In the present study the level of average wage (W) is used as one of the main explanatory variables of the two basic price equations, the consumer price index (CPI) and the implicit deflator of the GNP at market prices (PGNPM). The former (CPI) is employed in the formation of the relative prices in the consumption functions, and its range of change is used as the indicator of the inflation rate. The latter (PGNPM) forms the basic explanatory variable in estimating the implicit deflators of the different components of the national expenditure.

The average wage is also utilized to calculate total wage income which was subsequently used as explanatory variable in the equations determining direct taxes.

To arrive at the series of the level of average wage, the annual values of total wages and salaries of the national income accounts were employed. (They exclude the wages in the agricultural sector which are given with the income from other sources). From these figures the value of wages and salaries from abroad was subtracted and the outcome was then divided by the number of employed in industry and other activities (agricultural workers are excluded).

From the above brief account of the various theories, which purport to explain the formation of wages and prices, the existence of a close relation and a high degree of mutual influence between them is to be generally accepted.

As it has been generally suggested by economic theories wages are influenced by the excess demand in the labour market, usually measured by the reciprocal of the unemployment rate. This relation is further augmented by taking into consideration the effects of the expectation of prices, invoked in the wage setting process (to avoid erosion of the living standards) and by the longer term influence of productivity changes.

Prices are usually formed on a mark up basis proportionate over costs. The mark up margin is then related to the level of excess demand for products. Costs consist of wages, the cost of material inputs and the cost of capital services[16]. The effects of productivity on prices are allowed, either indirectly through a time trend (as in the previously mentioned model of optimal pricing)[17] or using the unit labour costs as the measure of the price of labour costs, calculated as compensation per man-hour over output per man-hour (productivity). It is usually preferred on theoretical grounds[18], as it has been mentioned above, to use the normal unit labour costs as the measure of the price of labour, that is pricing is based on the long run movements in productivity and the factor costs and not on their short-run variations[19].

In this study, following this general approach of examining the formation and the factors affecting wages and prices, already presented, the average wage is based on the conditions of demand in the labour market, augmented by price expectations and influenced by movements in the average productivity. Thus, it is postulated that the average wage (W) is a function of unemployment (UN) (as a measure of the demand pressure in the labour market), expected prices (P^e) and the average productivity (PROD), that is

8.11.1 $W = f\ (UN, P^e\ , PROD)$

The consumer price index (CPI) and the GNP deflator (PGNPM), of the mark up form, are postulated to be a function of the average wage (W), the unit value index of imports (PMG), the rate of indirect taxes (RIT) and affected by average productivity (PROD), that is

8.11.2 $CPI = f\ (W, PMG, RIT, PROD)$

and

8.11.3 PGNPM = f (W, PMG, RIT, PROD)

The rate of indirect taxes is calculated as the ratio of total indirect taxes over the value of final expenditure. The average productivity (PROD) is calculated by subtracting from the figures of real GNP the value of the agricultural sector at constant terms, and dividing the outcome by the number of employed in industry and other activities (agricultural workers are excluded). For all the prices used in the estimation of the above equations the base year is 1970.

8.12 The Results of the Estimation of Wage and Price Equations

The above functions for wages and prices explain their movements to the long run equilibrium, or desired level. Because of uncertainty, administration delays, long run contracts and the effects of market structures, wages and prices do not adjust instantaneously to the long run levels.

To account for their short run behaviour, a partial adjustment mechanism is also postulated. That is, in each period only a fraction of the difference between desired and previous period actual level will be realized.

It is also assumed that

a) the above functions (8.11.1) to (8.11.3) can be adequately approximated by linear equations and

b) the consumer price index lagged by one period is a close proxy for expected prices, that is $P^e = CPI_{t-1}$.

Consequently these functions for wages and prices and the partial adjustment mechanism for each of them are:

$$W_t^e = a_o + a_1 CPI_{t-1} + a_2 F(UN) + a_3 PROD_t + u_{1t}$$

$$W_t - W_{t-1} = \gamma (W_t^e - W_{t-1}) \qquad 0 \leq \gamma \leq 1$$

$$CPI_t^e = b_o + b_1 W_t + b_2 PMG + b_3 RIT_t + b_4 PROD_t + u_{2t}$$

$$CPI_t - CPI_{t-1} = \delta (CPI_t^e - CPI_{t-1}) \qquad 0 \leq \delta \leq 1$$

and

$$PGNPM_t^e = c_o + c_1 W_t + c_2 PMG_t + c_3 RIT_t + c_4 PROD_t + u_{3t}$$

$$PGNPM_t - PGNPM_{t-1} = \lambda \ (PGNPM^e - PGNPM_{t-1}) \quad 0 \leq \lambda \leq 1$$

Where the variables W^e, CPI^e and $PGNPM^e$ denote the long run equilibrium or desired levels of the variable W, CPI and PGNPM, and γ, δ and λ are the adjustment coefficients for each equation, constrained in the interval between zero and one.

The variable F(UN) is a function of the unemployment.

The theory developed around the Phillips curve and other related empirical studies have shown that the impact of unemployment changes on wage rates is larger when unemployment is very low[20]. That is, an increase in employment will not create an excess demand for labour when high levels of unemployment exist throughout the different sectors of the economy.

On the contrary, when unemployment is very low an increase in the demand for labour will result in excess demand for labour and consequently in substantial increases in wages. On the other hand wages react slowly to down swings of the economy. To account for this non linear relation between wages and unemployment (which is a proxy for the excess demand for labour) a function of unemployment F(UN) is inserted in the wage equation. This function usually takes the form of the reciprocal of unemployment.

In this study the term F(UN) in the wage equation is also used in the form of the reciprocal of the unemployment $(\frac{1}{UN})$, but the level of unemployment (UN) was also employed.

Thus, substituting the above equilibrium equations for wages and prices into the corresponding adjustment functions, rearranging terms and using $\frac{1}{UN}$ for F(UN) the estimated equations are derived as:

8.12.1 $$W_t = a_o\gamma + a_1\gamma CPI_{t-1} + a_2\gamma UN_t^{-1} + a_3\gamma PROD_t + (1-\gamma)W_{t-1} + v_{1t}$$

8.12.2 $$CPI_t = b_o\delta + b_1\delta W_t + b_2\delta PMG_t + b_3\delta RIT_t + b_4\delta PROD_t + (1-\delta)CPI_{t-1} + v_{2t}$$

8.12.3 $$PGNPM_t = c_o\lambda + c_1\lambda W_t + c_2\lambda PMG_t + c_3\lambda RIT_t + c_4\lambda PROD_t + (1-\lambda)PGNPM_{t-1} + v_{3t}$$

Where the error terms v_{1_t}, v_{2_t}, v_{3_t} satisfy the standard assumptions.

The results of the estimation of the equation (8.12.1) for the average wage revealed some problems concerning the above formulation of the wage equation. The productivity variable (PROD) was always statistically insignificant (the t value considerably less than one) and had almost invariably a wrong sign (negative). An increase in wages is expected when productivity increases, as it has been suggested by economic theory (E. Kuh, and Santomerro A. and J. Seater).

The average productivity variable used in the regression reflects short run fluctuations. However, it has been maintained[(21)] that firms relate their product prices in fluctuations in costs which are considered as more permanent.

Thus firms will not be influenced in setting prices or coming into agreement in the wage bargaining process by short run fluctuations in productivity. They will react accordingly if they expect that productivity changes will hold in the future.

In an attempt to account for the firms expectations concerning the average productivity[(22)] and assuming that the average productivity achieved in the previous period will also hold for the current period, the average productivity variable lagged by one period ($PROD_{t-1}$) was inserted in the equation (8.12.1).

The results showed a slight improvement. In most cases the coefficient has the expected sign (positive), its magnitude was ranging between 0.03 and 0.10, but it was statistically insignificant (the t statistic value was still less than one).

Thus it was not possible to establish any significant effect of productivity on average wages. These poor results may be probably attributed to the fact that the variable used is not a good measure to account for the long run movements of the average productivity and hence to reflect properly firms expectations about it.

The second problem concerned the lagged dependent variable W_{t-1}. Its coefficient, always significant and positive, had a very large magnitude.

In most cases the coefficient exceeded one, implying a negative value for the adjustment coefficient, γ, contrary to the assumption that γ should be between zero and one. In the cases in which the coefficient of the lagged dependent variable was less than one, its magnitude was ranging between 0.91 to 0.99 (larger when the productivity variable was dropped).

These values of the lagged dependent variable imply very long mean lags, the shorter being around 9½ years. It should also be mentioned that the coefficient of W_{t-1} exceeded also one when the equation (8.12.1) was estimated in logarithmic or in first differences form.

Unemployment measured in thousands per year was entered in the equation (8.12.1) either in levels (UN) or in its reciprocal form (1/UN). For both forms the current and the lagged period values were used[(23)].

In most cases the coefficient has the right sign, but its magnitude, and hence its impact on the level of average wages, was small.

At the same time, the coefficient of the unemployment variable was mildly significant (the value of the t statistic almost always exceeded unity) and in several cases it was statistically significant at one or two tail test.

The results have shown that the current period reciprocal of the unemployment $\frac{1}{UN}t$ performed better than the other unemployment variables UN_t, UN_{t-1} and $\frac{1}{UN}t-1$ used in the wage equation. The coefficient of $\frac{1}{UN}t$ had always the correct sign and it was in most cases statistically significant, suggesting a preference for a non linear relation $(\frac{1}{UN})$ between wages and unemployment.

The coefficient of the lagged consumer price index (CPI_{t-1}), used as a proxy for the effect of price expectations on wages, was the most robust. It was statistically significant almost in all cases, had the correct, positive, sign, while its magnitude was between 0.25 and 0.30, as shown in the following sample of estimates of equation (8.12.1). In the brackets below the coefficients the absolute values of t statistic are:

$$W_t = \underset{(1.50)}{-\ 14.88} + \underset{(2.54)}{0.265}CPI_{t-1} - \underset{(2.19)}{0.055}UN_t - \underset{(0.17)}{0.008}PROD_t + \underset{(7.78)}{1.0015}W_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.52 INC. SEE = 1.595

$$W_t = \underset{(5.73)}{-\ 17.44} + \underset{(4.82)}{0.245}CPI_{t-1} - \underset{(0.55)}{0.014}UN_{t-1} + \underset{(20.86)}{1.025}W_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.54 INC. SEE = 1.79

$$W_t = \underset{(9.72)}{20.32} - \underset{(4.69)}{0.165}CPI_{t-1} + \underset{(2.78)}{12.81}\frac{1}{UN}t-1 - \underset{(9.74)}{0.23}PROD_{t-1}$$

$$+ \underset{(38.59)}{1.53}W_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.84 N.A. SEE = 2.11

$$W_t = - \underset{(2.99)}{28.01} + \underset{(3.32)}{0.338}CPI_{t-1} + \underset{(1.64)}{100.302}\frac{1}{UN}t + \underset{(0.66)}{0.0356}PROD_{t-1}$$

$$+ \underset{(7.04)}{0.91}W_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.64 INC. SEE = 1.55

$$W_t = - \underset{(2.45)}{23.85} + \underset{(2.81)}{0.298}CPI_{t-1} + \underset{(1.59)}{112.65}\frac{1}{UN}t + \underset{(0.21)}{0.012}\ PROD_{t-1}$$

$$+ \underset{(7.24)}{0.95}W_{t-1} \qquad \rho = \underset{(0.91)}{0.20}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.84 N.A. SEE = 1.548

$$W_t = - \underset{(2.18)}{24.43} + \underset{(2.77)}{0.3047}CPI_{t-1} - \underset{(0.67)}{0.018}UN_{t-1} + \underset{(0.75)}{0.0445}PROD_{t-1}$$

$$+ \underset{(6.80)}{0.94}W_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.708 N.A. SEE = 1.659

$$W_t = - \underset{(0.77)}{9.72} + \underset{(2.35)}{0.247}CPI_{t-1} - \underset{(2.12)}{0.082}UN_{t-1} - \underset{(0.42)}{0.027}PROD_{t-1}$$

$$+ \underset{(7.63)}{1.02}W_{t-1} \qquad \rho = \underset{(1.43)}{-0.30}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.98 N.A. SEE = 1.53

$$\Delta W_t = \underset{(1.54)}{1.789} + \underset{(1.73)}{0.218}\Delta CPI_{t-1} - \underset{(1.59)}{0.129}\Delta PROD_{t-1}$$

$$+ \underset{(0.88)}{12.459}\Delta \frac{1}{UN}_{t-1} + \underset{(8.19)}{1.112}\Delta W_{t-1}$$

$R^2 = 0.80$ $\quad \bar{R}^2 = 0.76$ $\quad$ DW = 1.18 INC. $\quad$ SEE = 4.846

$$\ell n W_t = \underset{(71.01)}{3.057} - \underset{(5.27)}{0.308}\ell n CPI_{t-1} + \underset{(1.84)}{0.053}\ell n \frac{1}{UN}_{t-1}$$

$$- \underset{(10.74)}{0.689}\ell n PROD_{t-1} + \underset{(30.09)}{1.477}\ell n W_{t-1}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad$ DW = 2.26 N.A. $\quad$ SEE = 0.043

As the postulated partial adjustment function of the form $W_t - W_{t-1} = \gamma\,(W_t^e - W_{t-1})$ imposes a restrictive lag pattern with geometrically declining weights, which may not be appropriate in the case of wages, the equation (8.12.1) was estimated by the Almon polynomial lag technique. The equation was estimated with a second or third degree polynomial distributed lag for five periods and without end restrictions. The polynomial lag was applied in separate estimations for lagged wages and lagged prices in order to examine the effects of past wages and past prices on current average wage level. The results showed a pattern of coefficients with alternating signs, while very few of them were, either significant as in the case of lagged wages, or with a t value exceeding one as in the case of lagged prices.

Although the results of the estimation with the polynomial distributed lag (some of them reported below) have displayed wrong signs and pointed out to the presence of positive autocorrelation (the value of the Durbin-Watson statistic was in the inconclusive region), they also indicated that

a) only the first period lagged price (CPI_{t-1}) is important for wages. Longer lags have coefficients small in magnitude with wrong signs and statistically insignificant. And

b) wages lagged one or two periods exercise a very strong influence on the level of average wage as their coefficients were statistically significant and large in magnitude, especially the coefficient for W_{t-1} whose magnitude was in excess of one.

$$W_t = \underset{(0.57)}{-8.195} + \underset{(1.68)}{0.225CPI}_{t-1} - \underset{(1.63)}{0.096UN}_t + \underset{(0.30)}{0.0241PROD}_{t-1}$$

$$+ \underset{(3.47)}{1.168W}_{t-2} + \underset{(2.24)}{0.194W}_{t-2} - \underset{(1.28)}{0.307W}_{t-3} - \underset{(1.58)}{0.337W}_{t-4}$$

$$+ \underset{(0.93)}{0.106W}_{t-5} \qquad \Sigma a_i = \underset{(1.37)\,\text{st.dev.}}{0.824}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad DW = 1.52$ INC. $\quad SEE = 1.867$

$ML = -\ 0.183$

St.dev (2.49)

$$W_t = \underset{(0.49)}{10.368} + \underset{(1.06)}{77.05}\,\frac{1}{UN}_t - \underset{(0.95)}{0.077PROD} + \underset{(5.52)}{1.234W}_{t-1} + \underset{(9.36)}{0.149CPI}_{t-1}$$

$$- \underset{(0.13)}{0.0098CPI}_{t-2} - \underset{(1.38)}{0.089CPI}_{t-3} - \underset{(1.98)}{0.088CPI}_{t-4} - \underset{(0.28)}{0.007CPI}_{t-5}$$

$$\Sigma a_i = \underset{(0.76)\,\text{st.dev.}}{-\ 0.0448}$$

$ML = -\ 0.505$

St.dev (1.78)

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad DW = 1.52$ INC. $\quad SEE = 1.692$

The results from the estimation of the wage equation (8.12.1) either by using a distributed lag with geometrically declining weights or by the Almon's technique showed a considerable wage inertia[24] as the large magnitude of the coefficient of lagged dependent variable (W_{t-1}) indicated. That wage feedback mechanism is further reinforced by price expectations as the significance of the coefficient of lagged prices points out, while the effect of unemployment is small.

All the above mentioned results have indicated some problems arising from the magnitude of the coefficient of lagged dependent variable. In a great number of cases it exceeds one, violating the assumption that the adjustment coefficient should be less than or equal one. Even in those cases where its magnitude is less than one it implies a long mean lag in excess of nine years, which does not seem plausible, as neither does the long run elasticity for price expectations exceeding 5[25]. Thus it was decided to drop from the equation (8.12.1) the lagged dependent variable W_{t-1}.

After dropping the lagged dependent variable W_{t-1}, for the above stated reasons, and the productivity variable which was almost always insignificant, the average wage level was regressed on the consumer price index lagged by one period (CPI_{t-1}) and on the inverse of unemployment, that is

$$8.12.4 \qquad W_t = a_o + a_1 CPI_{t-1} + a_2 \frac{1}{UN_t} + u_t$$

with the following results of ordinary least squares estimation (figures below the coefficients are absolute values of the t statistic at 5% level of significance).

8.12.5 $$W_t = -\underset{(16.89)}{78.4653} + \underset{(22.05)}{1.2106}CPI_{t-1} + \underset{(5.67)}{895.498}\frac{1}{UN}_t$$

$R^2 = 0.98$ $\bar{R}^2 = 0.98$ DW = 0.65 POS. SEE = 6.47475

As the magnitude of the Durbin-Watson statistic indicates the existence of positive autocorrelation the above equation was re-estimated by generalised least squares with a first order autocorrelation process[26] and resulted in

8.12.6 $$W_t = -\underset{(6.68)}{67.3637} + \underset{(17.06)}{1.1834}CPI_{t-1} + \underset{(3.43)}{661.43}\frac{1}{UN}_t \qquad \rho = \underset{(5.07)}{0.75}$$

$R^2 = 0.95$ $\bar{R}^2 = 0.95$ DW = 1.87 N.A. SEE = 4.60767

The 2SLS estimation (the procedure mentioned previously), shown below, had the same low value for the Durbin-Watson statistic (0.70) and thus it was also discarted in favour of the equation corrected for first order autocorrelation, which also has a very high $\bar{R}^2$ and the included variables possess the expected signs. (However the equation estimated by 2SLS indicates that equation (8.12.6) underestimates the coefficient of the unemployment variable[27].)

$$W_t = -\underset{(16.00)}{78.1121} + \underset{(18.94)}{1.1626}CPI_{t-1} + \underset{(5.81)}{1107.6}\frac{1}{UN}_t$$

DW = 0.70 POS. SEE = 6.7917

The above results of the equation (8.12.6) show that the estimates of the coefficients are biased upwards as they picked up the effect of the lagged dependent variable (excluded for the reasons stated above), with which they are highly correlated. This is especially reflected in the estimate of the wage elasticity with respect to expected price which is 1.90 (this elasticity when the lagged dependent variable was included was around 0.50). On the other hand, the elasticity with respect to unemployment is - 0.17 (in other estimated equations whether they included or not the lagged dependent variable the elasticity with respect to unemployment was ranging between - 0.02 to - 0.17).

The coefficient of the lagged price CPI_{t-1} in the preferred equation (8.12.6) exceeds one, indicating an inflationary tendency in wages. But this property (of inflationary tendency) was also present in the equations which included the lagged dependent variable. This was indicated by the sum of the coefficients of lagged prices and lagged wages, which always exceeded one.

This equation (8.12.6) was then projected for the next two years. The constancy of the parameters outside the sample period was rejected as the value of the $Z_{1(k)}$ statistic was 32.442 (the critical value of χ^2 distribution with two degrees of freedom is 5.992).

The forecasts which were generated using the above preferred equation for the next two years showed that the equation underestimates the average wage level for both years. The actual figures, the forecasts and the deviations of the former from the latter are as follows: (figures in thousand drs).

	Actual	Forecasts	Deviations
1978	244	227	- 17
1979	293	273	- 20
Sum of Absolute Deviations			37

The root mean square error (RMSE) and the root mean square percentage error (RMSPE) were also calculated. These figures, 18.5 thousand drs and 6.9% respectively, although they could be considered satisfactory, indicate that there is scope for improvement in the equation which determines the average wage.

After the main part of this work had been completed some efforts were made to improve the wage equation. Some better results were produced which, although not incorporated in the model are presented below as they show a possible line of improvement.

In this attempt to improve these results, the productivity variable lagged by one period ($PROD_{t-1}$) was re-introduced in the wage equation. The results by OLS, compared with those of equation (8.12.6) showed the absence of first order autocorrelation in the residuals, as the value of the Durbin-Watson statistic indicated. (When estimated by generalised least squares, the autocorrelation coefficient ρ had a magnitude of 0.05 and the value of the t statistic was 0.22). But at the same time as the results below demonstrate, the coefficient of $PROD_{t-1}$, which has picked the effects of the excluded lagged dependent variable with which it is highly correlated, has a large magnitude of 0.37 which seems implausible as indicative of the effects of productivity on wages (the implied elasticity is 0.75). The magnitude of the coefficient of CPI_{t-1} is moreover still in excess of one:

$$W_t = \underset{(32.46)}{93.125} + \underset{(31.65)}{1.047}CPI_{t-1} + \underset{(1.16)}{140.368}\frac{1}{UN}t + \underset{(7.95)}{0.376}PROD_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.71 N.A. SEE = 3.0645

In apart from these considerations, the forecasts generated by this equation are markedly inferior to those of equation (8.12.6) as the figures of 31.5 thousand drs and 11.5% for the RMSE and the RMSPE respectively demonstrate.

The analysis of the results of the wage equation has shown that the coefficient of the lagged dependent variable was near one or exceeded, at times, significantly this figure. But even when the magnitude of the coefficient of lagged dependent variable (W_{t-1}) was less than one, its sum with the coefficient of the CPI_{t-1} (proxy for price expectations) had always exceeded unity. Hence it was decided to estimate the wage equation by constraining to one the sum of the coefficients of CPI_{t-1} and W_{t-1} that is

$$W_t = a_o + a_1 CPI_{t-1} + a_2 \frac{1}{UN^t} + a_3 W_{t-1} \text{ and } a_1 + a_3 = 1 => a_3 = 1 - a_1$$

Substituting for a_3 in the above equation we get

$$W_t = a_o + a_1 CPI_{t-1} + a_2 \frac{1}{UN}t + (1 - a_1) W_{t-1}$$

after rearranging terms

$$W_t = a_o + a_1 \ (CPI_{t-1} - W_{t-1}) + a_2 \frac{1}{UN}t + W_{t-1}$$

or

$$\Delta W_t = a_o + a_1 \ (CPI_{t-1} - W_{t-1}) + a_2 \frac{1}{UN}t$$

The OLS estimation of the above equation gave poor results, as shown below. The $\bar{R}^2$ was very low (0.45), the coefficient of CPI_{t-1} was statistically insignificant ($t = 1.06$) and the very low magnitude of the Durbin-Watson statistic (0.39) indicated that the equation is mispecified.

$$\Delta W_t = - \underset{(1.29)}{21.05} + \underset{(1.06)}{0.279} \ (CPI_{t-1} - W_{t-1}) + \underset{(3.39)}{775.66} \frac{1}{UN}t$$

$R^2 = 0.51$ $\bar{R}^2 = 0.45$ DW = 0.39 POS. SEE = 7.3125

That this equation, with the imposed constrain of $a_1 + a_3 = 1$ could not explain the average wage was corroborated when the equation was re-estimated for a first order autocorrelation process, with the following results:

$$\Delta W_t = \underset{(1.14)}{14.72} + \underset{(0.84)}{0.157}(CPI_{t-1} - W_{t-1}) + \underset{(0.82)}{138.14} \frac{1}{UN}t \qquad \rho = \underset{(9.23)}{0.90}$$

$R^2 = 0.05$ $\bar{R}^2 = - 0.005$ DW = 0.48 POS. SEE = 3.27127

As these results demonstrate (insignificant coefficients, R^2, and the magnitude of the Durbin-Watson statistic), this equation has not any explanatory power and the imposed constraint $a_1 + a_3 = 1$ could not be accepted.

The coefficient a_3 of the lagged dependent variable W_{t-1} was also constrained to one, that is the wage equation was estimated in the form

$$W_t = a_o + a_1 CPI_{t-1} + a_2 \frac{1}{UN}t + W_{t-1}$$

or

$$\Delta W_t = a_o + a_1 CPI_{t-1} + a_2 \frac{1}{UN}t$$

The results of the estimation of the above equation were satisfactory. The equation has a high goodness of fit, statistically significant coefficients and the Durbin-Watson statistic points to the absence of autocorrelation. (When the equation was estimated for first order autocorrelation the relevant coefficient ρ of a magnitude of 0.25 was statistically insignificant; the value of the t statistic was 1.15). The results of the above equation estimated by the procedure of 2SLS are reported below:

$$\Delta W_t = \underset{(19.72)}{-\ 21.202} + \underset{(19.69)}{0.266} CPI_{t-1} + \underset{(2.20)}{92.507} \frac{1}{UN}t$$

DW = 1.50 N.A. SEE = 1.49559

The forecasts generated by this equation are satisfactory. The RMSE of the average wage level is 1.6 thousand drs, while the

RMSPE was 0.6%. The hypothesis of the constancy of the parameters outside the sample period is accepted at the 5% level, as the value of the $Z_1(2)$ statistic is 2.235 (the critical value is 5.992). The elasticity of wages with respect to CPI_{t-1} is 0.45 (very near to the figure of 0.50 when the lagged dependent variable was included) while the elasticity with respect to unemployment is negligible (- 0.02).

8.13 The Results of the Estimation of the Basic Price Equations

Preliminary estimates by ordinary least squares of equation (8.12.2) for the consumer price index (CPI) and (8.12.3) for the implicit deflator of GNP at market prices (PGNPM) revealed that the coefficients of current productivity (PROD) and the rate of indirect taxes (RIT) have wrong signs and were statistically insignificant (the value of the t statistic was considerably less than one for both variables). As it has been already mentioned, productivity should have a negative effect on prices (mark-up of models Section 8.10 and Nordhaus model of optimal long run pricing Section 8.9), while an increase in the rate of indirect taxation could lead, ceteris paribus, in higher prices.

Considering what has been stated above about the relation between wages and productivity it was decided to insert productivity lagged by one period ($PROD_{t-1}$) in both equations. In the case of the effects of the rate of indirect taxes on prices both its change (ΔRIT) and its lag (RIT_{t-1}) were tried alternatingly in both equations, the latter (RIT_{t-1}) on the assumption that changes in the indirect tax rate affects prices with some delay. In the CPI equation the lagged productivity gave encouraging results, having the correct (negative) sign and a statistically significant coefficient in most cases. In the PGNPM equation the lagged productivity variable continued to present the same problems (wrong sign and insignificant coefficient). Thus, it was dropped from the equation for PGNPM and substituted by a time trend assuming neutral technological change progressing smoothly at an exponential rate(28). A negative sign is then expected for the coefficient of the time trend. Hence the two price equations incorporating the partial adjustment mechanism were estimated in the form:

8.13.1 $$CPI_t = b_o\delta + b_1\delta W_t + b_2\delta PMG_t + b_3\delta RIT_{t-1} + b_4\delta PROD_{t-1} + (1-\delta)CPI_{t-1} + v_{2_t}$$

8.13.2 $$PGNPM_t = c_o\lambda + c_1\lambda W_t + c_2\lambda PMG_t + c_3\lambda RIT_{t-1} + c_4\lambda T + (1-\lambda)PGNPM_{t-1} + v_{3_t}$$

Where the error term v_{2_t} and v_{3_t} are assumed to have the properties of zero expected value and constant variance. When estimated by ordinary least squares the following results were obtained.

8.13.2 $$CPI_t = \underset{(2.29)}{34.3701} + \underset{(3.29)}{0.4638}W_t + \underset{(5.67)}{0.3678}PMG_t + \underset{(0.31)}{0.3163}RIT_{t-1} - \underset{(0.86)}{0.0564}PROD_{t-1} + \underset{(0.16)}{0.0277}CPI_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.80 N.A. SEE = 2.157

8.13.3 $$PGNPM_t = \underset{(3.46)}{21.8047} + \underset{(7.15)}{0.5342W_t} + \underset{(5.22)}{0.313PMG_t} + \underset{(0.57)}{0.5571RIT_{t-1}} + \underset{(1.10)}{0.3163T} + \underset{(0.03)}{0.0038PGNPM_{t-1}}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.36 INC. SEE = 2.031

In both equations the coefficients have the expected signs (except for the coefficient of the time trend in the equation for the GNP implicit deflator). The cost variables e.g. W_t, PMG_t will have a positive, and productivity a negative effect on prices according to economic theory (Mark-up and Nordhaus models).

Only those of wages (W) and the unit value index of the imports of goods (PMG) are significant. The basic feature of the results, in both equations, is the very small magnitude of the coefficient of the lagged dependent variables. The magnitudes of 0.0277 and 0.0038 imply a very fast, almost instantaneous, adjustment. As the value of the t statistic is very low it has been decided to drop the lagged dependent variable from both equations. They were re-estimated with the following results:

8.13.4 $$CPI_t = \underset{(3.14)}{35.892} + \underset{(6.29)}{0.482W_t} + \underset{(6.66)}{0.372PMG_t} + \underset{(0.40)}{0.3701RIT_{t-1}} - \underset{(1.78)}{0.065PROD_{t-1}}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.77 N.A. SEE = 2.097

8.13.5 $$PGNPM = \underset{(1.28)}{15.709} + \underset{(7.11)}{0.514W_t} + \underset{(6.20)}{0.335PMG_t} + \underset{(1.04)}{1.108RIT_{t-1}} + 0.236T$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.33 INC. SEE = 2.017

There is no significant change in the magnitude of the coefficients compared with those of the equations (8.13.2) and (8.13.3), except that the coefficient of the rate of indirect taxes (RIT) in the equation (8.13.5) for the GNP deflator almost doubled and the t value exceeded one. Also the variable $PROD_{t-1}$ in the equation (8.13.4) for CPI was significant at one tail test.

Although only for the equation of the GNP deflator the Durbin-Watson statistic was in the inconclusive region, both equations were tested for a first order autocorrelation process. The results demonstrated the absence of first order autocorrelation in the residuals of the CPI equation, as the magnitude of the autocorrelation coefficient was very small ($\rho = 0.10$) and statistically insignificant ($t = 0.47$). As the results below show, the autocorrelation coefficient for the GNP deflator is of considerable magnitude and, although statistically insignificant, the value of the t statistic exceeds 2, bringing it to near significance:

8.13.6
$$PGNPM_t = \underset{(1.71)}{20.802} + \underset{(8.42)}{0.577}W_t + \underset{(5.93)}{0.304}PMG_t + \underset{(0.86)}{0.934}RIT_{t-1} + \underset{(0.004)}{0.0014}T \qquad \rho = \underset{(2.04)}{0.40}$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 1.96 \text{ N.A.} \qquad SEE = 1.875$$

Because of the mutual causality and simultaneous determination of wages and prices[29] the above equations (8.13.4) and (8.13.5) were also estimated by 2SLS[30] and the following results were obtained:

8.13.7
$$CPI_t = \underset{(1.64)}{24.773} + \underset{(4.56)}{0.423}W_t + \underset{(5.90)}{0.424}PMG_t + \underset{(1.05)}{1.333}RIT_{t-1} - \underset{(1.95)}{0.0797}PROD_{t-1}$$

$$DW = 1.94 \text{ N.A.} \qquad SEE = 2.161$$

8.13.8 $$PGNPM_t = \underset{(0.20)}{3.747} + \underset{(5.40)}{0.485W_t} + \underset{(4.97)}{0.373PMG_t} + \underset{(1.38)}{2.248RIT_{t-1}} - \underset{(0.007)}{0.0025T}$$

DW = 1.34 INC. SEE = 2.086

The above results compared with those of OLS estimates (8.13.4) and (8.13.5) show that there is an overestimation of the effects of wages on prices. Moreover the effects of the other explanatory variables have been underestimated to different degrees.

A dummy variable was also added to both equations to capture the effect of the oil price increase in 1974. But its coefficient was statistically insignificant, the t value barely exceeding one; it was thus excluded from the equations.

From the model of pricing presented above [30a] it is clear that the cost of capital services should be included in the price function. Because of the lack of data (for example capital estimates that could be used to construct the cost of capital services variable) the rate of interest for long term loans (RL) was employed instead as a proxy for the cost of capital services in both equations.

The results were unsuccessful, indicating that the variable used is a very poor proxy for such a complicated variable for the cost of capital services. The current and lagged values of the interest rate (RL, RL_{t-1} and RL_{t-2}) or its change (ΔRL) were interchangeably tried. Only the two period lag in interest rates (RL_{t-2}) had a positive coefficient, but it was statistically insignificant (t value less than one), thus failing to establish any significant relation between prices and interest rates.

As it has been mentioned above, the firms are setting their prices by a mark up on factor costs. The mark up rate is then assumed to depend on the rate of increase of the aggregate demand for products[31]. The higher the rate of increase of the demand, the higher the pressure on prices, ceteris paribus. For the former, proxy variables are used and it is usually approximated by several measures of capacity utilization such as the gap between potential and actual output or the ratio of unfilled orders to capacity. The lack of suitable data precludes the use of variables as those mentioned above. Thus, the inverse of the unemployment and the change in the money growth (ΔCUR) were interchangebly used, as a proxy variable to account for the pressure of the rate of increase in aggregate demand on prices. The money growth was used because of the indirect role it plays as a factor determining aggregate demand[32]. To lessen the effects arising from the simultaneity of money growth and prices and to account for the possibility of delays between changes in money growth and its effects on prices, not only the variable ΔCUR but also its lagged value (ΔCUR_{t-1}) were used in the estimated equations for CPI and PGNPM.

The inclusion of the reciprocal of unemployment ($\frac{1}{UN}$) did not improve the results. In the CPI equation, it had the wrong sign and it was statistically insignificant, the value of the t statistic being close to one. In addition the inclusion of the reciprocal of unemployment caused a reversal in the sign of the rate of indirect tax variable. In the GNP deflator equation the inclusion of this variable ($\frac{1}{UN}$) had hardly produced any change, and although its coefficient had the expected sign, it was statistically zero, the t value being 0.10. When the variable ΔCUR was inserted in the price equation for CPI and PGNPM, it had the expected positive sign, but it was statistically insignificant (the value of t slightly less than one). On the other hand, the lagged change in money growth (ΔCUR_{t-1}) performed much better. Not only had it the expected sign but it was also statistically significant in both equations, as the results by OLS estimation show:

8.13.9 $$CPI_t = \underset{(4.41)}{42.7125} + \underset{(6.51)}{0.4311}W_t + \underset{(6.66)}{0.3245}PMG_t + \underset{(0.58)}{0.4545}RIT_{t-1} - \underset{(3.09)}{0.09906}PROD_{t-1} + \underset{(2.94)}{0.0009529}\Delta CUR_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.299 INC. SEE = 1.7304

8.13.10 $$PGNPM_t = \underset{(1.61)}{15.4393} + \underset{(7.76)}{0.4616}W_t + \underset{(6.69)}{0.2939}PMG_t + \underset{(2.18)}{1.8671}RIT_{t-1} - \underset{(0.77)}{0.1872}T + \underset{(3.40)}{0.001042}\Delta CUR_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.88 N.A. SEE = 1.5741

The inclusion of the variable ΔCUR_{t-1} has resulted in both equations, in a decrease in the magnitude of the coefficients of current period variables (W_t and PMG_t) and an increase in the corresponding magnitude of the lagged variables (RIT_{t-1} and $PROD_{t-1}$). As the wage variable (W_t) is calculated by dividing the figure for wages and salaries in national accounts by the number of employed, the possibility should not be excluded that this variable (W_t) exercised a demand effect on prices[33]. The inclusion of the variable ΔCUR_{t-1} to pick the effect of demand changes has thus resulted in a lower coefficient for the wage variable. The inclusion of ΔCUR_{t-1} has also resulted in increasing the value of the t statistic for the productivity($PROD_{t-1}$) and indirect tax variables (RIT_{t-1}) and the last one is now significant in the GNP deflator equation (8.13.10).

The Durbin-Watson statistic gave mixed results. On the one hand the inclusion of ΔCUR_{t-1} in the consumer price index equation (8.13.9) resulted in increasing the magnitude of this statistic from 1.77 (non autocorrelation region) to 2.29 (inconclusive region for negative autocorrelation). On the other hand, for the GNP deflator equation (8.13.10) the magnitude of the Durbin-Watson statistic also increased from the figure 1.33 (inconclusive region) to 1.88 thus indicating the absence of first order autocorrelation in the residuals.

Because of the mixed results regarding the magnitude of the Durbin-Watson statistic both equations were re-estimated by incorporating a first order autocorrelation process in the error term ($u_t = u_{t-1} + \varepsilon_t$):

$$CPI_t = \underset{(4.77)}{42.847} + \underset{(7.31)}{0.436W_t} + \underset{(7.14)}{0.332PMG_t} + \underset{(0.58)}{0.396RIT_{t-1}}$$

$$- \underset{(3.63)}{0.099PROD_{t-1}} + \underset{(2.74)}{0.00083\Delta CUR_{t-1}} \qquad \rho = \underset{(0.93)}{-\ 0.20}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.41 INC. SEE = 1.6425

$$PGNPM_t = \underset{(1.48)}{15.005} + \underset{(7.33)}{0.468W_t} + \underset{(6.56)}{0.297PMG_t} + \underset{(2.06)}{1.899RIT_{t-1}}$$

$$- \underset{(0.80)}{0.212T} + \underset{(2.96)}{0.00097\Delta CUR_{t-1}} \qquad \rho = \underset{(0.46)}{0.10}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.002 N.A. SEE = 1.6168

These results indicate the absence of autocorrelation in the residuals only for PGNSM. For both equations the magnitude of the autocorrelation coefficient is very small and statistically insignificant, with a t value less than one. While there is not any important difference between the above estimates and those obtained by OLS for the equation for CPI, the value of the Durbin-Watson statistic for CPI corrected for autocorrelation (2.41) moved further into the inconclusive region for negative autocorrelation.

The 2SLS estimates for both price equations including the variable ΔCUR_{t-1} are the following:

$$8.13.11 \qquad CPI_t = \underset{(4.07)}{41.0495} + \underset{(6.05)}{0.4155}{}_t + \underset{(6.54)}{0.3325}PMG_t + \underset{(1.06)}{0.5764}\quad{}_{t-1}$$

$$- \underset{(3.04)}{0.0977}PROD_{t-1} + \underset{(3.02)}{0.00098}\Delta CUR_{t-1}$$

$$DW = 2.29 \text{ INC.} \qquad\qquad SEE = 1.73346$$

$$8.13.12 \qquad PGNPM_t = \underset{(0.29)}{4.1984} + \underset{(5.65)}{0.4317}W_t + \underset{(5.56)}{0.33008}PMG_t + \underset{(2.22)}{2.935}RIT_{t-1}$$

$$- \underset{(1.30)}{0.4082}T + \underset{(2.66)}{0.00105}\Delta CUR_{t-1}$$

$$DW = 1.66 \text{ INC.} \qquad\qquad SEE = 1.6569$$

In both equations there is a decrease in the magnitude of the coefficients of wage variable (W_t) compared with the OLS estimates, while the magnitude of the coefficients of all other variables were increased, indicating the important effect of simultaneity.

All the variables are statistically significant, except the rate of indirect taxes variable in the equation for CPI (8.13.11) and the time trend in the equation for the GNP deflator (8.13.12), but the t value for both these variables now exceeds one.

Both equations include variables suggested by economic theory, which they have the expected signs. The effect of the proxy variable for the increase in aggregate demand (ΔCUR_{t-1}) is almost similar for both prices as the magnitude of its coefficient indicates.

The response of prices to the other explanatory variables present differences as the corresponding coefficients show. The GNP contains the public sector with the large share of wages and salaries in the value added and, probably, the complicated structure of the indirect taxation affects generally more severely the production of the non-traded sector of the economy. Thus wages and the rate of indirect taxes have a relatively larger impact on the GNP deflator (PGNPM) than on the consumer price index (CPI) as the corresponding coefficients demonstrate.

A disadvantage of the above equations (8.13.11) and (8.13.12) is that the magnitude of the Durbin-Watson statistic, for both of them lies in the inconclusive region.

For the consumer price index (CPI) the magnitude of the Durbin-Watson statistic is in the inconclusive region (the upper bound for non autocorrelation is 2.18) whether the equation was estimated by OLS (DW = 2.30), OLS with autocorrelation correction (DW = 2.41, ρ = - 0.20 and insignificant t = 0.93) or 2SLS (DW = 2.29). Thus, as the 2SLS is the proper procedure for estimation, the statistical properties of this function are more satisfactory while the magnitude of the Durbin-Watson statistic is not worse, it was decided to select the equation (8.13.11) for the consumer price index.

For the GNP deflator (PGNPM) the Durbin-Watson magnitude (1.67 - inconclusive region) of the 2SLS estimation indicates the possibility of positive autocorrelation in the residuals. On the contrary both for OLS and OLS corrected for autocorrelation the Durbin-Watson statistic shows the absence of autocorrelation. (The magnitude of the Durbin-Watson statistic is 1.88 and 2.00 respectively while the autocorrelation coefficient $\rho = 0.10$ is insignificant $t = 0.46$.) Because of the serious consequences of autocorrelation, it was decided to prefer the equation estimated by OLS for the GNP deflator, instead of the one estimated by 2SLS which is suspect of autocorrelation.

To sum up, the selected equations for the consumer price index (CPI) estimated by 2SLS and the implicit deflator for GNP at market price (PGNPM) estimated by OLS are:

8.13.11 $$CPI_t = \underset{(4.07)}{41.0495} + \underset{(6.05)}{0.4155}W_t + \underset{(6.54)}{0.3325}PMG_t + \underset{(1.06)}{0.5764}\ {}_{t-1} - \underset{(3.04)}{0.0977}PROD_{t-1} + \underset{(3.02)}{0.00098}\Delta CUR_{t-1}$$

DW = 2.29 INC. SEE = 1.73346

8.13.10 $$PGNPM_t = \underset{(1.61)}{15.4393} + \underset{(7.76)}{0.4616}W_t + \underset{(6.69)}{0.2939}PMG_t + \underset{(2.18)}{1.8671}RIT_{t-1} - \underset{(0.77)}{0.1872}T + \underset{(3.40)}{0.00104}\Delta CUR_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.88 N.A. SEE = 1.5741

From the above equations the elasticities of the two prices with respect to the explanatory variables were calculated at the mean values of the variables:

Elasticities		
	CPI	PGNPM
W	0.21	0.27
PMG	0.41 [34]	0.35
RIT 1	0.12	0.19
PROD 1	- 0.13	-

It should be mentioned that some equations were estimated in logarithmic form but they did not produce better results. They suffered from statistical problems (low magnitude Durbin-Watson statistic and wrong signs for some coefficients). There were also equations estimated with an Almon distributed polynomial lag of second or third degree for five periods and without end restrictions for the wage variable for both equations. The results showed that only the current wage was statistically significant and with the expected positive sign (as it has been shown in the mark-up and Nordhaus models).

The above equations were also used to generate forecasts for the two subsequent years 1978 and 1979 [35]. The actual data the forecasts and the deviations of the former from the latter are given in the following table:

	CPI			PGNPM		
	Actual	Forecast	Deviations	Actual	Forecast	Deviations
1978	257	260	3	260	265	5
1979	306	301	-5	309	306	-3
Sum of Absolute Deviations			8			8

To test the constancy of the parameters outside the sample the $Z_{1(k)}$ statistic was calculated. The value of this statistic with two degrees of freedom is $Z_{1(2)} = 10.442$ for the equation (8.13.11) for CPI and $Z_{1(2)} = 13.722$ for the equation (8.13.10) of PGNPM. These values are in excess of the critical value of the χ^2 distribution with two degrees of freedom which is 5.992 (36). To test the forecasts generated by the equations the root mean square error (RMSE) and the root mean square percentage error (RMSPE) were calculated. For the consumer price index the RMSE is 4.1 and for the GNP deflator is 4.3. The RMSPE is 1.4% and 1.6% respectively. Although the forecasting period is small these figures show that the equations perform quite satisfactorily.

8.14.1 Other Price Equations

For the implicit deflators of the consumption and investment expenditure categories of the model, some preliminary estimates were made by regressing these implicit deflators on factor costs, similar to those equations of the consumer price index and the GNP deflator.

The results were not satisfactory, whether the estimated equations were linear or logarithmic. They had insignificant coefficients with contrary to the expected signs, large standard errors of the regression; particularly the Durbin-Watson statistic many times indicated positive autocorrelation, thus pointing to specification error. To be appropriate, such a detailed estimation would clearly require data on cost factors (e.g. wages, import prices, rates of indirect taxation) to be specific to each of these categories of expenditure. As it stands, the use of the data related to the whole of economic structure (like the average wage or the rate of total indirect taxation) failed to produce consistent and meaningful results.

It was thus decided to estimate the implicit deflators of the above expenditure categories, regressing them on the implicit deflator of the GNP, assuming that there is, in the long run, a close proportional relation between the particular expenditure deflators and the GNP deflator.

To this basic relation other variables were introduced which were considered of particular importance to any specific deflator, such as for example the price of imports. To account for the influence of long run factors (e.g. tastes) in the composition of final expenditure and hence of their effects on prices, a time trend was also introduced. Finally, the current or lagged nominal value of each expenditure category (e.g. the nominal value of the consumption of non-durables expenditure) was introduced as a proxy, although a very imperfect one, (it does not account for the multiple factors, demographic, tastes, etc.) for the effects of demand pressure of any expenditure category on its deflator. As an increase in demand pressure will lead, ceteris paribus, to an increase in prices a positive sign is expected for this variable.

The partial adjustment mechanism, employed in the previous Section, was also introduced in order to account for a possible delayed response of each deflator to its long run equilibrium level.

The estimated equations for each implicit deflator have generally the form:

$$8.14.1 \qquad P_{it} = a_{io}\, b_i + a_{i1}\, b_i\, PGNPM + a_{i2}\, b_i\, Z_{it} + (1-b_i)\, P_{it-1} + u_{it}$$

Where $0 \leq b_i \leq 1$ and b_i is the adjustment coefficient for each deflator.

P_i = the various deflators.

Z_i = the particular variables employed in the equations

u_{it} = the error term of each equation satisfying the standard assumptions and

a_{io}, a_{i1}, a_{i2} coefficients to be estimated.

The implicit deflators (P_i) estimated were those corresponding to the consumption and investment categories used in the model, that is the

a) consumption of non-durables (PCND),

b) consumption of durables (PCD),

c) consumption of services (PCS),

d) housing investment (PHI),

e) construction investment (PCI),

f) equipment investment (PEI), and finally

g) the implicit deflator for inventory investment (PII).

For all the price variables used in the equations either as dependent or explanatory variables the base year is 1970.

All the above deflators were estimated both in linear and log-linear form and the selection made was based on statistical considerations, such as goodness of fit, test for autocorrelation, and on information provided by economic theory such as the expected signs of the explanatory variables.

8.14.2 Implicit Deflators of Consumption Expenditure Categories

a) The implicit deflator for consumption of non-durables (PCND)

In addition to the GNP deflator (PGNPM), the explanatory variables used in this equation were the current or lagged nominal value of consumption of non-durables (CNDV), the time trend (T) and the unit value index of imports (PMG). The last variable was introduced in some of the deflators because, either the foreign markets are to a great extent the main source of these products or, even if the domestic production provides some of these products, with the increase in incomes, expenditure patterns will be diverted to products of better quality and greater variety for which imports are a necessary source. Thus an increase in the price of imported goods will contribute to the increase of the PCND deflator.

Several combinations of these variables were tried. The time trend was always insignificant (the t value less than 0.50), while the nominal value of consumption of non-durables (CNDV) current or lagged was not only statistically insignificant, (the t value around 1) but had the wrong sign as well (while as it has been already explained a positive sign was expected). Only the coefficient of the imports price had the correct (positive) sign and the value of the t statistic was near the significance level.

The most satisfactory equation was:

$$PCND_t = \underset{(0.43)}{0.526} + \underset{(12.72)}{0.842}PGNPM_t + \underset{(1.59)}{0.033}PMG_t + \underset{(2.00)}{0.135}PCND_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.22 INC. SEE = 1.3849

Because the magnitude of the Durbin-Watson statistic was very low (a feature shared by most of the estimated equations), the above equation was re-estimated for a first order autocorrelation process. The results, shown below, confirmed the existence of a significant positive autocorrelation in the residuals:

8.14.2a $$PCND_t = \underset{(1.89)}{2.663} + \underset{(13.80)}{0.8436}PGNPM_t + \underset{(2.70)}{0.0723}PMG_t + \underset{(1.10)}{0.0677}PCND_{t-1} \quad \rho = \underset{(2.36)}{0.45}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.39 N.A. SEE = 1.1307

As the 2SLS estimation produced coefficients similar to those of OLS estimation and it also had an equally low Durbin-Watson statistic, it was decided to retain in the model the above equation (8.14.2a) which satisfies the criteria stated above.

b) <u>The implicit deflator for consumption of durables (PCD)</u>

The demand pressure variable (CDV) gave the same poor results as it was the case with the price of consumption of non-durables. It was always statistically insignificant and with the wrong sign. The time trend for the deflator of this consumption category was statistically significant, exceeding many times its standard error and showing a steady decline of the price level of durables through time. The level of the import price was also insignificant ($t = 0.36$) but its change (ΔPMG) was statistically significant at one tail test.

It should also be mentioned that the log-linear functions were statistically inferior (the indication for autocorrelation was always very strong).

The more adequate from the estimated equations was the following:

8.14.2b $$PCD_t = \underset{(3.84)}{14.3862} + \underset{(7.56)}{0.5848}PNGPM_t + \underset{(2.05)}{0.0873}\Delta PMG_t - \underset{(5.69)}{0.5112}T + \underset{(3.23)}{0.3611}PCD_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.71 N.A. SEE = 1.4895

The autocorrelation coefficient was statistically insignificant, as the estimation of the above equation for a first order autocorrelation showed ($\rho = 0.35$ and the t statistic was 1.75).

Moreover the 2SLS estimates (shown below) were similar to those of equation (8.14.2b) while the Durbin-Watson statistic was in the inconclusive region. Thus the above equation (8.14.2b) was finally preferred.

$$PCD_t = \underset{(2.04)}{16.327} + \underset{(6.49)}{0.622}PGNPM_t + \underset{(1.64)}{0.0783}\Delta PMG_t - \underset{(5.03)}{0.522}T + \underset{(2.19)}{0.304}PCD_{t-1}$$

DW = 1.55 INC. SEE = 1.5026

c) The implicit deflator of consumption of services

The deflator of this consumption category exhibited the same problems as the previous two consumption deflators, as far as the inclusion of the nominal value of consumption of services (CSV) is concerned. Both forms, CSV_t and CSV_{t-1}, had coefficients with wrong (negative) signs and were statistically zero. In addition to these defects which were shared by the log-linear functions the latter also exhibited strong positive autocorrelation.

As services are labour intensive activities and are positively influenced by changes in the remuneration of labour, the wage variable (W) and its change (ΔW_t) were also tried, but their coefficients had a negative sign and were dropped from the equation. The same pattern of unsatisfactory results turned out when the rate of indirect taxes, purged of the duties rate component was introduced in the equation. The time trend was also statistically zero. Thus the equation for the implicit deflator of the consumption of services (PCS), estimated by OLS, was explained by the GNP deflator and the lagged dependent variable.

When the equation was re-estimated for a first order autocorrelation the relevant coefficient ρ was small in magnitude (0.25) and insignificant ($t = 1.21$).

Finally the equation estimated by 2SLS was retained in the model as it had significant coefficients and the Durbin-Watson statistic indicated the absence of autocorrelation. This equation is:

$$8.14.2c \qquad PCS_t = \underset{(3.93)}{7.3965} + \underset{(13.73)}{0.6325}PGNPM + \underset{(4.38)}{0.2973}PCS_{t-1}$$

$DW = 1.48$ N.A. $\qquad SEE = 1.4132$

The finally retained equations for the implicit deflators of the three consumption categories, that is of the: consumption of non-durables (PCND) estimated by OLS with a first order autocorrelation correction, consumption of durables (PCD) estimated by OLS, and consumption of services (PCS) estimated by 2SLS, were:

8.14.2a
$$PCND_t = \underset{(1.89)}{2.663} + \underset{(13.80)}{0.8436}PGNPM_t + \underset{(2.70)}{0.0723}PMG_t + \underset{(1.10)}{0.0677}PCND_{t-1} \qquad \rho = \underset{(2.36)}{0.45}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.39 N.A. SEE = 1.1307

8.14.2b
$$PCD_t = \underset{(3.84)}{14.3862} + \underset{(7.56)}{0.5848}PGNPM_t + \underset{(2.05)}{0.0873}\Delta PMG_t - \underset{(5.69)}{0.5112}T + \underset{(3.23)}{0.3611}PCD_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.71 N.A. SEE = 1.48951

8.14.2c
$$PCS_t = \underset{(3.93)}{7.3965} + \underset{(13.73)}{0.6325}PGNPM_t + \underset{(4.38)}{0.2973}PCS_{t-1}$$

DW = 1.48 N.A. SEE = 1.4132

In all three equations the explanatory variables have theexpected signs, satisfy the standard statistical considerations (such as goodness of fit, Durbin-Watson statistic) and have statistically significant coefficients, except for the coefficient of the lagged dependent variable ($PCND_{t-1}$) of the equation (8.14.2a) but it was kept in the equation as the value of the t statistic exceeded one and this variable also allows for the delay adjustment of the dependent variable to its equilibrium level.

The mean lag of this equation for PCND (8.14.2a) is very small, implying a very fast response of this implicit deflator to its long run level. The mean lag for the equation (8.12.2b) is 0.57, while the corresponding figure for the third equation (8.12.2c) is 0.43. These figures imply that the delayed response is slightly over half a year for the implicit deflator PCD and slightly under half a year for the PCS deflator. The short run elasticities of the above implicit deflators with respect to GNP deflator are 0.83 for PCND, 0.58 for PCD and 0.65 for PCS. The corresponding figures for the implied long run elasticities, 0.89, 0.91 and 0.93 respectively, are near to one. A long run elasticity of one is expected for the deflators to be proportional to the GNP deflator (in a long run equilibrium).

Forecasts were generated by the above equations for the next two years and the results, the actual figures and the deviations of the actual figures from the forecasts are presented below.

Although the forecast sample is small, the equations were tested for the constancy of the parameters outside the sample. The value of $Z_{1(2)}$ statistic was 15.644, 22.536 and 6.529 for the implicit deflators PCND, PCD and PCS respectively. As these figures are in excess of the critical value 5.992 (χ^2 distribution with 2 degrees of freedom) the hypothesis of parameters constancy cannot be accepted.

At the same time, the results of the calculation of the root mean square error (RMSE) and the root mean square percentage

	PCND			PCD			PCS		
	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations
1978	256	260	4	231	230	-1	236	234	-2
1979	303	305	2	278	271	-7	276	273	-3
Sum of Absolute Deviations			6			8			5

error (RMSPE) showed that the two years forecasts generated by the equations were satisfactory. The RMSE and the RMSPE are shown in the table below:

	RMSE	RMSPE
PCND	3.2	1.2%
PCD	4.9	1.8%
PCS	2.5	1.0%

8.14.3 Implicit Deflators of Investment Expenditure Categories

a) The implicit deflator for housing investment (PHI)

In the basic equation the dependent variable (PHI) was regressed on the GNP deflator (PGNPM), the nominal value of housing investment (HIV) and the lagged dependent variable. The GNP deflator was the only significant variable; the nominal value of housing investment (HIV) although statistically insignificant, had the expected sign. But the lagged dependent variable had a negative sign, violating the assumption that the adjustment coefficient should be less than one. When the variable HIV lagged by one period was included in the equation, it was proved statistically significant; but the lagged dependent variable retained the negative sign. The time trend was then included in the equation and proved to be highly significant. The lagged dependent variable had the correct sign, as the time variable picked up the strong negative trend, while the variable HIV_{t-1} remained significant. This equation estimated by OLS was:

$$PHI_t = -\underset{(3.30)}{8.403} + \underset{(5.75)}{0.8252}PGNPM_t + \underset{(5.90)}{0.000974}HIV_{t-1}$$

$$-\underset{(6.17)}{1.1127}T + \underset{(2.02)}{0.262}PHI_{t-1}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.99$ $\quad$ DW = 1.93 N.A. $\quad$ SEE = 2.0153

However the 2SLS estimates demonstrated a strong simultaneity between the GNP deflator and the dependent variable,as the coefficient of PGNPM decreased to 0.7212. As the Durbin-Watson statistic of the equation estimated by 2SLS is satisfactory it was decided to retain this equation, given below, in the model:

8.14.3a $$PHI_t = -\underset{(2.20)}{6.9494} + \underset{(3.77)}{0.7212}PGNPM_t + \underset{(5.24)}{0.001065}\ HIV_{t-1}$$

$$-\underset{(5.74)}{1.1757}T + \underset{(2.07)}{0.3543}PHI_{t-1}$$

DW = 1.77 N.A. $\quad$ SEE = 2.0446

b) <u>The implicit deflator for construction investment (PCI)</u>

As with most of the other price equations, the implicit deflator for construction investment (PCI) produced the same sequence of wrong signs and insignificant coefficients for current or lagged nominal value of construction investment (CIV).

The reciprocal of unemployment $(\frac{1}{UN})$ was then used as an alternative proxy for the effects of the pressure of the demand. Its use was prompted by the role which investment plays in increasing the productive capacity of the economy, and unemployment has been considered a measure more closely connected to the relation between capacity and fluctuations in economic activity.

Although this variable had the correct sign it was however statistically insignificant.

The lagged dependent variable was always statistically insignificant, with a very low value for the t statistic and in most cases had a negative sign, and thus it was dropped from the equation.

Finally the most satisfactory equation was a linear one, relating the implicit deflator of construction investment to the GNP deflator, the time trend and the average wage. This equation estimated by OLS is given below:

$$PCI = - \underset{(0.67)}{8.0422} + \underset{(4.01)}{0.9125}PGNPM_t + \underset{(1.25)}{0.3034}W_t - \underset{(1.10)}{0.4204}T$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.98 N.A. SEE = 4.4648

The last two variables, although statistically insignificant, (the t value exceeds one) were kept in the equation, as they improved the statistical properties of this equation (goodness of fit, Durbin-Watson statistic) relative to those of the equation which excluded them.

The Durbin-Watson statistic of magnitude 1.98 points to the absence of autocorrelation in the residuals, a feature shared by the 2SLS estimates of this equation. Thus the latter was retained in the model

8.14.3b $$PCI = - \underset{(0.68)}{9.2018} + \underset{(3.68)}{0.9339}PGNPM_t + \underset{(1.03)}{0.2791}W_t - \underset{(0.96)}{0.3853}T$$

DW = 1.98 N.A. SEE = 4.4661

c) The implicit deflator of equipment investment (PEI)

The basic feature of the equation for PEI, as compared with the other price equations, was that the linear equations performed significantly worse than those estimated in logarithmic form. The Durbin-Watson statistic showed positive autocorrelation in the residuals even when the lagged dependent variable was included. In the equations estimated in log-linear form the magnitude of the Durbin-Watson statistic increased considerably and frequently indicated no autocorrelation. In some cases the GNP deflator had a wrong sign, while in other cases it was statistically insignificant with a very low value for the t statistic and thus it was dropped from the equation. The lagged dependent variable coefficient was always significant and large in magnitude, implying a long mean lag for this deflator. The unit value index of imports (PMG) was also statistically significant, as equipment investment is heavily dependent on imports, while the wage variable gave mixed results concerning the statistical significance of its coefficient (the value of the t statistic was ranging between one and two). Neither the current nor lagged nominal value of equipment investment(EIV) had any impact, being always insignificant, while the reciprocal of unemployment had performed satisfactorily and was included in the equation that determines the implicit deflator of equipment investment (PEI). The results from ordinary least squares estimation (the estimation for autocorrelation correction produced a magnitude of -0.10 for the autocorrelation coefficient,ρ while the value of the t statistic was 0.44) of PEI in logarithmic form are as follows:

$$\ell n PEI_t = \underset{(0.87)}{0.2376} + \underset{(0.96)}{0.02658} \ell n W_t + \underset{(3.89)}{0.1857} \ell n PMG_t$$

$$+ \underset{(2.37)}{0.0646} \ell n \frac{1}{UN} t + \underset{(6.59)}{0.802} \ell n PEI_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.18 N.A. SEE = 0.0309

As the coefficient of the wage variable was insignificant and the value of the t statistic was less than one, this variable (W_t) was dropped from the above equation, which was then re-estimated by OLS (the value of the autocorrelation coefficient ρ when the equation was estimated by generalised least squares was -0.15 and statistically insignificant the value of the t statistic being 0.67). The results are as follows:

$$\ell n PEI = \underset{(0.76)}{0.178} + \underset{(4.11)}{0.177} \ell n PMG_t + \underset{(3.05)}{0.0707} \ell n \frac{1}{UN} t + \underset{(15.43)}{0.852} \ell n PEI_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 2.26 N.A. SEE = 0.03018

The equation was also estimated by 2SLS. It also had satisfactory statistical properties such as high value for the Durbin-Watson statistic and thus it was retained in the model. This equation is:

8.14.3c
$$\ell n PEI_t = \underset{(0.31)}{0.072} + \underset{(3.85)}{0.1692} \ell n PMG_t + \underset{(2.42)}{0.06107} \ell n \frac{1}{UN} t$$

$$+ \underset{(15.28)}{0.8745} \ell n PEI_{t-1}$$

DW = 2.24 N.A. SEE = 0.03037

d) <u>The implicit deflator of inventory investment (PII)</u>

The GNP deflator was the only significant variable to explain the implicit deflator of inventory investment. Other variables included (e.g. the price of imports or its change, the interest rate, as a proxy for the cost of borrowing, the nominal value of inventories) did not have any impact. The lagged dependent variable was also insignificant and in some cases with a wrong (negative) sign violating the assumption that the adjustment coefficient (b) should be between zero and one. Only a negative time trend was found significant, giving an improvement to the fit of the equation. (The $\bar{R}^2$ increased to 0.75 from 0.67.)

After testing for autocorrelation, which was found insignificant, the equation was estimated by 2SLS with the following results:

8.14.3d $$PII = \underset{(0.81)}{11.9141} + \underset{(6.35)}{1.5295}PGNPM_t - \underset{(2.55)}{4.1148}T$$

DW = 2.04 N.A. SEE = 27.1575

Thus the following equations for the implicit deflators of the investment expenditure, estimated by 2SLS, were retained in the model:

8.14.3a $$PHI_t = -\underset{(2.20)}{6.9494} + \underset{(3.77)}{0.7212}PGNPM_t + \underset{(5.24)}{0.00106}\,HIN_{t-1}$$

$$-\underset{(5.74)}{1.1757}T + \underset{(2.07)}{0.3543}\ {}_{t-1}$$

DW = 1.77 N.A. SEE = 2.0446

8.14.3b $$PCI_t = -\underset{(0.68)}{9.2018} + \underset{(3.68)}{0.9339}PGNPM - \underset{(0.96)}{0.3853}T + \underset{(1.03)}{0.2791}W_t$$

DW = 1.98 N.A. SEE = 4.4661

8.14.3c $$\ell n PEI_t = \underset{(0.31)}{0.072} + \underset{(3.85)}{0.1692}\ell n PMG + \underset{(2.42)}{0.06107}\ell n \frac{1}{UN_t} + \underset{(15.28)}{0.8745}\ell n PEI_{t-1}$$

DW = 2.24 N.A. SEE = 0.03037

8.14.3d $$PII = \underset{(0.81)}{11.9141} + \underset{(6.35)}{1.5295}PGNPM_t - \underset{(2.55)}{4.1148}T$$

DW = 2.04 N.A. SEE = 27.1575

From the estimates of the lagged dependent variable the implied mean lag is calculated. For the price of housing investment (PHI) the mean lag is 0.54, around half a year, while for the price of equipment investment (PEI) the corresponding figure is 6.9 years. This mean lag seems very long and suggests that the imposed lag structure with geometrically declining weights may not be suitable for this deflator.

The long run elasticity of PHI with respect to GNP deflator is 1.13 not much in excess of one, the value expected if the deflator is proportional to the GNP deflator, in a long run equilibrium (the short run elasticity is 0.73).

The elasticities of the implicit deflators for construction investment (PCI) and inventory investment (PII) with respect to GNP deflator are 0.97 and 1.34 respectively, the former being near one, and the latter far in excess of unity, casting thus doubts on the assumption that in the long run the implicit deflator of inventory investment (PII) is closely proportional to the GNP deflator.

For the implicit deflator of equipment investment (PEI)the calculated long run elasticity with respect to the price of imports (PMG) is about 1.35 while the long run elasticity with respect to the variable $\frac{1}{UN}$ (proxy for the pressure of aggregate demand) of - 0.49 is not negligible.

Although the forecast sample is small (two or three observations), the constancy of the parameters outside the sample period was tested by calculating the $Z_{1(k)}$ statistic. The results showed the null hypothesis of the parameters constancy cannot be accepted for the equations of PHI, PCI and PII for which the magnitude of the $Z_{1(k)}$ statistic is well in excess of the critical value of the χ^2 distribution.

On the other hand the magnitude of the $Z_{1(k)}$ statistic of 1.435 for the implicit deflator of equipment investment (PEI) is inside the critical value of 5.992 (χ^2 distribution with 2 degrees of freedom) indicating the stability of the parameters for PEI outside the sample.

Because of the lack of data for some of the explanatory variables involved in these equations, forecasts were generated for three years for the PHI and PII deflators and for two years for those of PCI and PEI. In the table below the actual and forecast values of the dependent variables and the deviations of the former from the latter are presented:

	PHI			PCI			PEI			PII		
	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations
1978	322	320	-2	308	292	-16	288	292	4	276	307	31
1979	415	407	-8	389	351	-38	325	335	11	338	378	40
1980	504	520	16	-	-	-	-	-	-	395	461	66
Sum of Absolute Deviations			26			54			15			137

To test the forecasts the root mean square error (RMSE) and the root mean square percentage error (RMSPE) were also calculated and are presented below:

	RMSE	RMSPE
PHI	10.4	2.2%
PCI	29.1	7.8%
PEI	8.3	2.6%
PII	47.9	13.5%

As both these tables demonstrate the forecasts generated from the equations of the implicit deflators of PHI and PEI can be considered quite satisfactory. On the other hand the equation for the price of construction investment fails to catch up with the actual prices, while the equation for PII overpredicts prices by an increasing margin.

8.15.1 Import - Export Prices

For both these two largest items of the country's international transactions, price equations were estimated separately for the categories of goods and services.

The unit value indices of the imports and exports of goods and the implicit deflators of the imports and exports were estimated. The unit value indices are given in the tables for international trade of the United Nations. The implicit deflators of the imports and exports of services were constructed using the national account data of OECD. From the value of imports and exports of goods and the corresponding unit value indices the country's imports and exports of goods in real terms were calculated. From the OECD data which give the sum of goods and services of imports and exports in real and value terms, the figures of the imports and exports of goods at current and constant prices were subtracted. These calculations resulted in four time series, two for the imports of services at current and constant terms, and two for the exports of services. Dividing the figures in value by those expressed in real terms the implicit deflators of the imports and exports of services were derived.

As Greece's imports are a very small fraction of the world trade they cannot exercise any influence in the international markets and hence the price of its imports is determined by the prevailing world export price of goods. To account for the effects of long term factors on the price of imports a time trend was also included in the equation. Thus for the import prices of goods and services the following linear functions were estimated

8.15.1 $$PMG_t = a_o + a_1 PWXG + a_2 T + u_{1t}$$

8.15.2 $$PMS_t = c_o + c_1 PWXG + c_2 T + u_{2t}$$

where PMG is the unit value index of the imports of goods, PMS the implicit deflator of the imports of services, PWXG the unit value index of the world exports of goods, and T the time trend.

All the above unit value indices are expressed in domestic currency units (drachmae), that is the unit value index of world exports of goods has been multiplied by the exchange rate (drachmae per U.S.A. dollar relative to 1970 prevailing rate). The base year for all prices is 1970.

On the other hand to maintain its share of the international trade and especially to increase its exports the country's exports sector should remain competitive. That is, in order to compete in the international markets the price at which the country's goods are sold abroad should not, ceteris paribus, deviate from the competitor's price. This hinges on the law of one price[(37)], according to which, the price of traded goods, in open economies, expressed in common currency units, will be equal in the long run for all countries. Thus the price of a country's exports depends heavily on the prevailing world price. But as it has been mentioned above[(38)] optimal pricing is based on factor costs. Hence firms set export prices by a mark up on their factor costs which then is assumed to depend on the world price (price of competitor's) and on capacity utilization[(39)].

According to this standard model, the long run elasticity of the export price with respect to both the domestic costs and the competitor's price sums up to one. This result can be derived at, by assuming that firms are profit maximizers subject to diminishing returns of scale because capital is fixed in the short run, perfect competition in the factors market and less perfect competition in the output market[(40)]. The implications of this model for a small country, with respect to the relative influence of factor costs and competitors' prices on its export price is, that the latter will be the significant factor[41].

Thus both the unit value index and the implicit deflator of Greece's exports of goods and services are assumed to be determined by the competitor's price (expressed in Greece's currency), domestic costs and the pressure on demand at home.

Persistent efforts have been undertaken to increase the country's exports of goods and services and to improve its competitiveness. Direct and indirect measures have been taken to assist the export sector of the economy by providing several incentives to increase exports, such as subsidies, favourable tax regime and terms of credits. These measures, aimed at improving the performance of the export sector, are translated into lowering the level of export prices to a certain extent. The impact of these measures should then be taken into consideration in determining the export price. Because of the variety of measures taken, and which are influenced by the type of goods and services exported a more disaggregated model is required. These measures, in order to be effective, may be frequently accompanied by suitable exchange rate policy. To account for their effects on export prices it was decided to use the exchange rate (ER) as a proxy variable for them. Thus a negative sign is expected.

The following model is then postulated for both the export price of goods and the implicit deflator for the export of services:

8.15.3 $$PXG = \gamma_o + \gamma_1 PGNPM_t + \gamma_2 PWXG_t + \gamma_3 ER_t + \gamma_4 Z_t + v_{1t}$$

8.15.4 $PXS = d_o + d_1 PGNPM_t + d_2 PWXG_t + d_3 ER_t + d_4 Z_t + v_{2t}$

where PXG is the unit value index of the export of goods (base year 1970), PXS the implicit deflator of the export of services (base year 1970), PGNPM, the GNP implicit deflator (base year 1970). This variable is used as a proxy for domestic costs. PWXG is the unit value index of world exports (base year 1970).

It is expressed in drachmae by being multiplied by the exchange rate index.

That is PWXG = PWX x ERI where PWX is the unit value index of world exports in USA currency and ERI the exchange rate index (base year 1970 equals 1.00).

ER is the exchange rate (drachmae per USA dollar) and Z the demand pressure variable. The reciprocal of unemployment $(\frac{1}{UN})$ was included in the equation as a proxy for it and v_{1t} and v_{2t} are the error terms obeying the standard assumptions. The expected signs of the coefficients, according to what has been stated above are

$$\gamma_1, \gamma_2, \gamma_4, \quad d_1, d_2, d_4 > 0 \qquad \text{and } \gamma_3, d_3 < 0$$

In all the above equations (8.15.1) to (8.15.4) a partial adjustment mechanism (similar to that of equation (8.14.1) which was used in the previous Section on domestic prices) was also included to account for a delay response of prices to their long run equilibrium levels. This mechanism implies the inclusion of the lagged dependent variable in each equation. It has been postulated that the unit value indices for the imports and exports of goods (PMG and PXG respectively) are primarily determined by the world price for goods, that is by the price of world export of goods (PWXG).

As no suitable index for the world price of services is available, the world price of the exports of goods (PWXG) was used as a proxy variable, in the estimation of the implicit deflators of the imports and exports of services (PMS and PXS respectively).

This proxy variable may poorly reflect the prevailing world price which determines the prices (implicit deflators) of the imports and exports of services for a particular country. So it was also decided to regress the implicit deflators on the unit value indices of the country's imports and exports of goods. They may be more closely related to the factors that affect these deflators, and so they may be better proxies than the price of world exports of goods (PWXG).

a) The results of import prices estimation

For both the import prices PMG and PMS the lagged dependent variable was insignificant with a t value considerably less than one. In addition, in the import of goods equation, the lagged dependent variable had a negative sign violating the assumption that the adjustment coefficient should be less than one. Thus, from both the equations of the import prices the lagged dependent variable was dropped. When the equations were re-estimated by ordinary least squares the following results were obtained:

8.15.5 $$PMG = \underset{(7.18)}{14.1125} + \underset{(47.36)}{0.965}PWXG - \underset{(3.48)}{0.6496}T$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.08 INC. SEE = 3.9955

8.15.6 $$PMS = \underset{(6.24)}{33.0927} + \underset{(11.52)}{0.6331}PWXG + \underset{(1.16)}{0.5837}T$$

$R^2 = 0.94$ $\bar{R}^2 = 0.93$ DW = 1.64 N.A. SEE = 10.7704

A dummy variable which was inserted in the equation to account for the increase in oil prices in 1974, proved to be for both equations insignificant and was then dropped. Because of the low value of the Durbin-Watson statistic which indicates that important variables may have not been introduced in the equations, the change in world export price (ΔPWXG) was also included in the equations. But ΔPWXG was insignificant in both equations and subsequently it was not retained. The equation for the implicit deflator of the imports of services (PMS) was then estimated, by OLS using as explanatory variable the unit value index of the imports of goods (PMG), instead of the world price of exports of goods (PWXG) and gave almost similar results, but in this case the time trend being significant

8.15.6a $$PMS_t = \underset{(4.13)}{25.1564} + \underset{(11.03)}{0.6493}PMG_t + \underset{(2.13)}{1.0497}T$$

$R^2 = 0.94$ $\bar{R}^2 = 0.93$ DW = 1.62 N.A. SEE = 11.1858

As the value of the Durbin-Watson statistic is low especially in (8.15.5) all equations were estimated by incorporating a first order autocorrelation process.

For the equations (8.15.6) and (8.15.6a) of PMS the results confirmed the absence of autocorrelation. As it was expected from the low value of the Durbin-Watson statistic (1.08) the equation for the import price of goods exhibits strong first order positive autocorrelation as the results below show.

$$\text{8.15.7} \qquad \underset{}{PMG} = \underset{(3.76)}{15.0344} + \underset{(28.53)}{0.9437PWXG} - \underset{(1.42)}{0.5575T} \qquad \rho = \underset{(2.70)}{0.50}$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 1.30 \text{ INC.} \qquad SEE = 3.7499$$

The autocorrelation coefficient of a magnitude 0.50 is statistically significant. The effect of correcting for autocorrelation resulted in an insignificant coefficient for the time trend but the t value is still in excess of one. The Durbin-Watson statistic although increased is still in the inconclusive region indicating that a more complex autocorrelation process may be at work. As no better equations could be estimated, the above equation (8.15.7) was retained in the model.

The elasticity of the price of imports of goods with respect to world price of exports implied by equation (8.15.7) is near one (the actual figure is 0.93) while the corresponding figure of 0.70 for the price of imports of services calculated from the equations (8.15.6) and (8.15.6a), shows that PMS is inelastic with respect to changes in the proxy variables PWXG or PMG. The estimates of the two equations (8.15.6) and (8.15.6a) are almost similar, but it was decided to retain the latter (8.15.6a) in the model, because it performs relatively better outside the sample period (the criteria used were the RMSE, the RMSPE and $Z_1(3)$).

The forecasts generated by these equations with the actual data and the deviations of latter from the former are given in the table below.

	PMG			PMS		
	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations
1978	302	300	-2	254	246	-8
1979	362	362	0	284	287	3
1980	488	507	19	377	369	8
Sum of Absolute Deviations			21			19

The constancy of the parameters outside the sample period is rejected for the price of imports of goods (PMG)($Z_{1(3)} = 25.956$) while it is accepted for the price of imports of services (PMS) ($Z_1(3) = 1.094$ while the critical value with 3 degrees of freedom is 7.815). But the latter result should be seen in conjunction with the large standard error of this regression (SEE = 10.7704).

The root mean square error (RMSE) and the root mean square percentage error (RMSPE) for the above equations are

	RMSE	RMSPE
PMG	11.0	2.3%
PMS	6.8	2.3%

As the table shows the forecasting results are quite satisfactory, for both equations.

On the other hand, the RMSPE for two years (1978-1979) was also calculated for both PMG and PMS. As the forecasting period increases the errors of forecasts are expected to accumulate. While the difference between the two estimates for RMSPE is small for PMS (from 2.1% for 2 years to 2.3% for three years forecasts) the corresponding difference for PMG is quite large (from 0.5% for two years to 2.3% for three years) indicating the deteriorating effects which, the overestimation of the large increase occurred in 1980 in PMG, had on the forecasting performance of this equation.

b) <u>The results of export prices equations</u>

When the equations (8.15.3) for PXG and (8.15.4) for PXS were estimated, the variable $\frac{1}{UN}$ (proxy for the pressure on domestic demand) was statistically insignificant (the t value was considerably less than one) and with a wrong (negative) sign, while a positive one was expected as stated above; so it was dropped from both equations.

The lagged dependent variable PXG_{t-1} in the equation (8.15.3) presented the same problems (significance and signs of the coefficient) as those encountered with the variable $\frac{1}{UN}$ and consequently it was also dropped from the equation. The lagged dependent variable of equation (8.15.4), PXS_{t-1}, had the expected positive sign, while the value of the t statistic was near one (0.90) and so was retained in the equation. The time trend was also introduced in both equations but only in the equation (8.15.3) for the export price of goods, had a mildly significant negative coefficient (t = 1.86) while for the PXS equation the t statistic was 0.50.

The main feature of the estimation of the equation (8.15.4) for PXS was the negative coefficient of the GNP deflator, the variable accounting for the effects of domestic factor costs in the equation. The change in the GNP deflator (ΔPGNPM) was then introduced in the equation, to capture the effect of the domestic costs changes on PXS. This variable was retained in the equation as it had the correct sign and its t value exceeded one. The OLS estimates were:

8.15.8
$$PXG = \underset{(3.41)}{107.105} + \underset{(1.58)}{0.6131}PGNPM_t + \underset{(2.27)}{0.4678}PWXG_t - \underset{(2.47)}{3.0173}ER_t - \underset{(1.86)}{1.4364}T$$

$$R^2 = 0.99 \quad \bar{R}^2 = 0.99 \quad DW = 0.94 \text{ INC.} \quad SEE = 4.4128$$

8.15.9
$$PXS = \underset{(1.87)}{87.8078} + \underset{(1.12)}{0.4933}\Delta PGNPM_t + \underset{(3.26)}{0.6661}PWXG_t - \underset{(1.59)}{2.967}ER_t + \underset{(1.45)}{0.364}PXS_{t-1}$$

$$R^2 = 0.99 \quad \bar{R}^2 = 0.99 \quad DW = 1.40 \text{ INC.} \quad SEE = 4.146$$

For both equations the magnitude of Durbin-Watson statistic is very low, especially for the equation of PXG suggesting that in both equations important variables may have been omitted. To improve the results the change in both the domestic and the world price (ΔPGNPM and ΔPWXG) were added in the equation (8.15.8), and the ΔPWXG variable in the equation (8.15.9).

For both equations these variables were statistically insignificant (the t statistic was 0.10 for ΔPGNPM and 0.22 for ΔPWXG in equation for PXG and 1.20 for ΔPWXG in the equation for PXS). But the increased number of explanatory variables resulted in making insignificant the coefficients for all variables, while the Durbin-Watson statistic was still inconclusive.

Both the equations were also re-estimated by excluding the domestic cost variables PGNPM from (8.15.8) and ΔPGNPM from (8.15.9). The results showed the persistence of the same problems (insignificance of some coefficients) and a low value for the Durbin-Watson statistic).

Some equations were also estimated with the lagged price of world exports ($PWXG_{t-1}$) replacing PWXG and with the wage variable (W_t) to account for the domestic costs, instead of PGNPM. But these changes did not lead to any improvement in the results. No further attempts were made to improve the results by including some lagged terms of the domestic costs and world export prices, as any increase in the number of variables (as the above case showed) would have led to insignificant coefficients.

Subsequently both the above equations (8.15.8) and (8.15.9) were re-estimated for a first order autocorrelation with the following results:

$$8.15.10 \quad PXG = \underset{(3.80)}{115.191} + \underset{(1.68)}{0.5328}PGNPM_t + \underset{(3.00)}{0.5304}PWXG_t$$

$$- \underset{(2.87)}{3.245}ER_t - \underset{(1.87)}{1.4505}T \qquad \rho = \underset{(3.08)}{0.55}$$

$$R^2 = 0.98 \qquad \bar{R}^2 = 0.98 \qquad DW = 1.62 \text{ INC.} \qquad SEE = 3.825$$

$$8.15.11 \quad PXS_t = \underset{(1.52)}{70.4082} + \underset{(0.87)}{0.352}\Delta PGNPM_t + \underset{(3.84)}{0.7478}PWXG_t$$

$$- \underset{(1.23)}{2.2684}ER_t + \underset{(1.02)}{0.2484}PXS_{t-1} \qquad \rho = \underset{(1.47)}{0.30}$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 1.57 \text{ INC.} \qquad SEE = 4.0796$$

The autocorrelation coefficient in the equation (8.15.10) for PXG is large in magnitude and highly significant, while for the PXS equation (8.15.11) it has a magnitude of 0.30 which is statistically insignifigant.

In both equations for PXS (8.15.9) and (8.15.11) the coefficient of the change in the domestic costs variable (ΔPGNPM) although with the correct (positive) sign, is statistically insignificant. In the former equation the value of the t statistic just exceeds one (1.12), while in the latter it is below that figure (0.87). Thus no significant relation was possible to be established between the change in the GNP deflator (ΔPGNPM) and the implicit deflator of the export of services. Hence this variable (ΔPGNPM) was not retained in the equation determining PXS.

In both the equations for PXG and PXS the exchange rate (ER) was also included as an explanatory variable (independently from its effects through the conversion of the world price of exports, expressed in USA dollars, into domestic currency), for the reasons stated.

A tentative attempt has been made to use the exchange rate variable as a proxy to account for the effects of the various measures (stated above) taken to keep or improve the competitiveness of Greece's exports. These would result in lowering the export prices. The variable (ER) had the expected (for the reasons already stated) negative sign in both the equations, determining the unit value index of the export of goods (PXG) and the implicit deflator for the export of prices (PXS), and was statistically significant (t = 2.87) only for the equation for PXG.

On the other hand, these results also showed that the magnitude of the coefficient of the exchange rate variable is small and its impact on the export prices would be unimportant. Moreover, the assumption that this variable (ER) could be an adequate proxy for the factors stated above is rather precarious. Thus it was decided to omit this variable (ER) not only from the equation for PXS in which it is statistically insignificant but also from the equation for PXG.

The re-estimation of the export price equations by ordinary least squares gave the following results:

8.15.12 $$\underset{(6.27)}{PXG = 30.1373} + \underset{(0.31)}{0.1176PGNPM} + \underset{(2.97)}{0.645PWXG} - \underset{(0.46)}{0.3263T}$$

$R^2 = 0.98$ $\quad \bar{R}^2 = 0.98$ $\quad$ DW = 1.06 INC. $\quad$ SEE = 4.97378

8.15.13 $$\underset{(3.41)}{PXS = 12.9574} + \underset{(8.21)}{0.9839PWXG} - \underset{(0.52)}{0.079PXS_{t-1}}$$

$R^2 = 0.99$ $\quad \bar{R}^2 = 0.98$ $\quad$ DW = 1.04 INC. $\quad$ SEE = 4.38165

In the above equation for PXG the coefficient for PGNPM has been considerably decreased as compared with the above mentioned results and the value of the t statistic is very low. While for the PXS equation the sign of the coefficient of the lagged dependent variable is inadmissible (violating the assumption that the adjustment coefficient is less than or equal to one).

The dummy variable D74 has a rather important effect on the price of the exports of goods (the t statistic 1.67 is near to one tail significance level) and hence it was retained in the equation, while the value of the t statistic for D74 in the equation for PXS was very low (0.19).

For reasons already stated, the equation for PXS was estimated again, replacing PWXG by the price of the exports of goods (PXG). These results, together with those for the equation of PXG (including the dummy variable), estimated by OLS are:

8.15.14 $$PXG = \underset{(5.82)}{27.861} + \underset{(0.99)}{0.391}PGNPM + \underset{(2.10)}{0.482}PWXG - \underset{(1.14)}{0.849}T + \underset{(1.67)}{9.336}D74$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 1.25 \text{ INC.} \qquad SEE = 4.75238$$

8.15.15 $$PXS = \underset{(7.50)}{26.468} + \underset{(9.47)}{1.059}PXG + \underset{(2.22)}{0.227}PXS_{t-1}$$

$$R^2 = 0.99 \qquad \bar{R}^2 = 0.99 \qquad DW = 1.34 \text{ INC.} \qquad SEE = 5.66502$$

As the Durbin-Watson statistic is in the inconclusive region for both the above equations, these were re-estimated for a first order autocorrelation process with the following results:

8.15.16

$$PXG = \underset{(5.11)}{28.3826} + \underset{(0.96)}{0.3618PGNPM} + \underset{(2.24)}{0.4977PWXG}$$

$$- \underset{(0.98)}{0.7889T} + \underset{(1.22)}{5.4767D74} \qquad \rho = \underset{(2.36)}{0.45}$$

$$R^2 = 0.98 \quad \bar{R}^2 = 0.98 \quad DW = 1.67 \text{ INC.} \quad SEE = 4.45343$$

8.15.17

$$PXS = - \underset{(4.36)}{23.1516} + \underset{(7.56)}{0.9926PXG} + \underset{(2.25)}{0.2642PXS_{t-1}} \qquad \rho = \underset{(2.04)}{0.40}$$

$$R^2 = 0.98 \quad \bar{R}^2 = 0.98 \quad DW = 1.68 \text{ N.A.} \quad SEE = 5.5564$$

The autocorrelation coefficient (ρ) in the equation for PXG is statistically significant. Although this equation was corrected for first order autocorrelation, the value of the Durbin-Watson statistic in (8.15.16) still lies in the inconclusive region, suggesting that a more complicated autocorrelation process may be at work with the export price of goods.

For the equation (8.15.17) of PXS, for which the Durbin-Watson statistic indicates the absence of significant autocorrelation, the relevant coefficient (ρ) is very near to significance level. The value of the t statistic 2.04 is close to the critical value of 2.086 at 5% level of significance. Thus, this equation was preferred to that estimated by OLS. It should be noted here that when equation (8.15.17) was estimated with the variable PWXG in the place of PXG, the autocorrelation coefficient increased to 0.65 and was statistically significant (t = 4.01), while the Durbin-Watson statistic was still in the inconclusive region (indicating a higher order autocorrelation process).

Because of the simultaneity effect arising from the endogeneity of the export prices (PXG, PXS) and the domestic cost variables (PGNPM), both equations were estimated by the 2SLS procedure and the results were:

$$\underset{}{PXG} = \underset{(5.79)}{31.939} + \underset{(0.05)}{0.0258PGNPM} + \underset{(2.53)}{0.69PWXG} - \underset{(0.19)}{0.174T} + \underset{(1.24)}{7.337D74}$$

DW = 1.23 INC. SEE = 4.86825

$$PXS = - \underset{(7.62)}{28.398} + \underset{(9.11)}{1.172PXG} + \underset{(1.11)}{0.13PXS_{t-1}}$$

DW = 1.40 INC. SEE = 5.80885

For the PXG equation the Durbin-Watson statistic remained in the inconclusive region but its magnitude decreased from 1.67 to the low level of 1.23, while for the PXS equation this statistic which in equation (8.15.17) indicated the absence of autocorrelation, in the above equation is in the inconclusive region. Because of the serious consequences of autocorrelation and because it was not possible to estimate the above equation by 2SLS with autocorrelation correction[42], it was decided to retain the equation (8.15.16) for PXG and (8.15.17) for PXS.

Although not much faith could be put in the above equation for PXG, estimated by 2SLS (suspected for autocorrelation), it nevertheless indicates that the coefficient of PGNPM in the retained equation (8.15.16) is biased upwards. (The magnitude of the coefficient for PGNPM decreased from 0.36 in equation (8.15.16) to only 0.025 in the equation estimated by 2SLS.)

As the value of the t statistic of the coefficient of PGNPM in equation (8.15.16) was less than one the equation was re-estimated by inserting this variable lagged by one period ($PGNPM_{t-1}$). But it resulted in a coefficient with a negative sign and statistically insignificant. The change in domestic costs (ΔPGNPM) when included in the equation instead of PGNPM had also a very low value for the t statistic (0.50).

Although the model of export prices, already analysed, indicates that to ignore domestic costs in determining export prices (PXG) could increase the risk of specification error, the PGNPM variable was dropped from the equation, which was then estimated by generalised least squares. The results presented the same problems concerning the presence of autocorrelation (low value of the Durbin-Watson statistic) without any important improvement. Thus the equation (8.15.16) was finally retained in the model.

The mean lag of the equation (8.15.17) for the implicit deflator of the export of services (PXS), implied by the estimate of the lagged dependent variable, is short, of around a quarter of a year, while the short and long run elasticities of PXS with respect to PXG are 0.94 and 1.28 respectively.

In the retained equation for PXG (8.15.16) the price coefficients (PGNPM and PWXG) show that the price of world exports (PWXG) has a greater weight in the formation of the price of exports of goods.

The elasticities of PXG, implied by the estimates of equation (8.15.16), with respect to the price of world exports of goods (PWXG) and to domestic costs (PGNPM) are 0.52 and 0.32

respectively, showing that the price of exports of goods is influenced considerably more by the prevailing world price, as it may be expected for the price of exports of a small country[43]. But these figures (sum of elasticities 0.84) sum up to less than one, which would be the case for the price of exports to depend on domestic costs and the price of the competitors[44]. Once more it should be stressed that the estimate for PGNPM is suspect and that it may also constitute an inadequate proxy for the effects of domestic costs on the price of exports of goods.

Some equations linear in logs were also estimated but they were affected by the same problems of insignificant coefficients with wrong signs and low values of the Durbin-Watson statistic.

The two equations retained in the model are[45]

8.15.16

$$\underset{(5.11)}{PXG = 28.3826} + \underset{(0.96)}{0.3618PGNPM} + \underset{(2.24)}{0.4977PWXG}$$

$$- \underset{(0.98)}{0.7889T} + \underset{(1.22)}{5.4767D74} \qquad \underset{(2.36)}{\rho = 0.45}$$

$R^2 = 0.98 \qquad \bar{R}^2 = 0.98 \qquad DW = 1.67$ INC. $\qquad SEE = 4.45343$

8.15.17

$$PXS = - \underset{(4.36)}{23.1516} + \underset{(7.56)}{0.9926PXG} + \underset{(2.25)}{0.2642PXS_{t-1}} \qquad \underset{(2.04)}{\rho = 0.40}$$

$R^2 = 0.98 \qquad \bar{R}^2 = 0.98 \qquad DW = 1.68$ N.A. $\qquad SEE = 5.5564$

The hypothesis of the constancy of the parameters outside the sample period was rejected for both equations as the value of the $Z_1(k)$ statistic is well in excess of the critical value of

7.815 with three degress of freedom. (The value of $Z_{1(3)}$ for PXG was 49.715 and for PXS 60.731.) In the table below the forecasts for the period 1978-1980 generated by the equations (8.15.16) and (8.15.17), the actual values and their deviations from the forecasts are given:

	PXG			PXS		
	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations
1978	250	261	11	299	294	-5
1979	277	305	28	357	332	-25
1980	383	392	9	427	462	35
Sum of Absolute Deviations			48			65

while the root mean square error (RMSE) and the root mean square percentage error (RMSPE) for both equations are:

	RMSE	RMSPE
PXG	18.13	6.5%
PXS	25.00	6.3%

Both equations overestimate the values of the export prices for the next three years. The figures of the above statistics RMSE and RMSPE are of considerable size and the results of the predictions cannot be regarded as quite satisfactory.

To sum up, some of the price equations perform quite adequately and their forecasts are reasonably satisfactory judged by RMSE and RMSPE criteria. For others, further effort is necessary, especially for the wage equation (crucial for the formation of the price equations), the forecasts of which considerably underestimate the actual figures.

FOOTNOTES TO CHAPTER EIGHT

1. J.A. Trevithick and C. Mulvey, The Economics of Inflation, 1975.

2. Trevithick and Mulvey, op. cit., p.14.

3. R.G. Lipsey, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862-1957: A Further Analysis", Economica, 27 (1960).

4. Lipsey, op. cit.

5. Lipsey, op. cit. p.31.

6. A.M. Santomero and J.J. Seater, "The Inflation - Unemployment Trade-Off: a Critique of the Literature", Journal of Economic Literature, 16 (June 1978).

7. Santomero and Seater, op. cit., p.516.

7a. Trevithick and Mulvey, op. cit.

8. M. Desai, Testing Monetarism, 1981, pp. 80-81.

9. Santomero and Seater, op. cit.

10. B.T. McCallum, "Rational Expectations and Macroeconomics Stabilization Policy", Journal of Money Credit and Banking, 12/4 (1980), part 2.

11. McCallum, op. cit.

12. E. Kuh, "A Productivity Theory of Wage Levels - An Alternative to the Phillips Curve", Review of Economic Studies, 34 (1967).

13. W.D. Nordhaus, "Recent Developments in Price Dynamics", in The Econometrics of Price Determination, O. Eckstein ed., 1972.

14. A significant limitation of this demand function is its unrealism for industries which are neither monopolistic nor competitive. See Nordhaus, op. cit.

15. Trevithick and Mulvey, op. cit.

16. For this general approach to wages and prices, see for example L.A. Dicks-Mireaux, "The Inter-relationship between Cost and Price Changes, 1946-1959", Oxford Economic Papers, 13 (1961); C.L. Schultze and J.L. Tryon, "Prices and Wages", in The Brookings Quarterly Econometric Model of the USA, J.S. Duesenberry,

G. Fromm, L.R. Klein and E. Kuh, eds., 1965; Kuh, op. cit. R.J. Gordon, "World Inflation and Monetary Accomodation in Eight Countries", Brookings Papers on Economic Activity (BPEA) (1977), 2; G.L. Perry, "Slowing the Wage-Price Spiral: the Macroeconomic View", BPEA, (1978), 2; E.M. Gramlich, "Macro Policy Responses to Price Shocks"; BPEA (1979) 1.

17. Nordhaus, op. cit.

18. Schultze and Tryon, op. cit.

19. For this approach, see for example, the references in footnote 16; also R.J. Gordon, "The Impact of Aggregate Demand on Prices", BPEA (1975) 3 and "Can the Inflation of the 1970's be Explained?", BPEA (1977) 1.

20. Lipsey, op. cit.; also Schultze and Tryon, op. cit.

21. Schultze and Tryon, op. cit.

22. Santomero and Seater, op. cit. They consider as one of the reasons of including productivity in the wage equation, that wages should rise even in equilibrium by the rate of increase in productivity, arising from technical progress. They argued that, in this case, the expected rate in productivity movements is needed, which it should be a long term average not distinguishable from the constant term in the regressions. Average productivity in the Greek economy, as measured by the variable PROD in this study, was growing by a rate between 4 and 7 percent annually in most years between 1955-1973 as the Table 8.1 (Appendix 1) shows. A three and five year moving averages of the average productivity were also constructed but as the figures were almost similar to those of PROD (see tables), it was decided to use the variable PROD. For the use of the productivity in the wage equation, in apart from E. Kuh's article, op. cit., see also J.D. Sargan, "Wages and Prices in the United Kingdom: a Study in Econometric Methodology", Economic Analysis for National Economic planning, ed. P.E. Hart, 1964.

23. The unemployment rate (in the place of the level of unemployment) was not used in the estimated equations, because to construct this variable the employment figures were required. As it has been mentioned in the Chapter 6 the accuracy of these figures is open to serious doubts, because of the way they have been estimated.

24. Perry, op. cit.

25. Even in those cases where the magnitude of the coefficient of lagged dependent variable is less than one it implies a long mean lag in excess of nine years. This magnitude does not seem plausible, as the country in the period covered by the sample experienced a significant rate of growth of the economy, rising incomes and improvement in the living standards, notwithstanding other important factors such as the pressure of organised labour. This result may indicate that the lag structure with geometrically declining weights is inappropriate for the wage function.

26. By the method mentioned in the previous chapters.

27. No attempt was made to estimate the equation by 2SLS with a first order autocorrelation correction. This was due to the large number of variables relative to the number of observations in the first stage of 2SLS. Thus either there were no degrees of freedom to permit estimation or there were very few so that the estimates collapsed to those of OLS.

28. Nordhaus, op. cit.

29. Import prices are endogenous, determined simultaneously with the other prices in the model.

30. The procedure using principal components described in previous chapters.

30a Nordhaus, op. cit.

31. Gordon, "The impact of aggregate demand on prices", op. cit.

32. Perry, op. cit. He refers to the role of money in determining aggregate demand. It should be mentioned that the use of the change in money growth has the disadvantage of mixing aggregate demand and supply effects; it combines both the effects of money changes to velocity and of prices to changes in the nominal GNP. For this point of view see R.G. Gordon "A Century on Wage and Price Stickiness in the United States, the United Kingdom and Japan", in Macroeconomics, Prices and Quantities, J. Tobin ed., 1983.

33. Nordhaus, op. cit.

34. G. Karatzas, "Inflationary Process in Fifty-Four Countries in the Past Decade: an Analysis", Economia Internazionale, 34 (1981). He has estimated that the magnitude of CPI elasticity with respect to PMG is 0.47 by fitting an equation of the form $\ell nCPI = a_o + a_1 \ell nCUR_{t-3} + a_2 \ell nPMG_t$ for the period 1968-1978 with annual data.

35. Forecasts for two more years up to 1981 were precluded by the lack of employment figures (to calculate average wage and productivity) and indirect taxes data.

36. As it has been mentioned in previous chapter, this statistic is biased against the null hypothesis of parameters constancy in small samples such as the present one.

37. P. Ormerod, "Manufactured Export Prices in the United Kingdom and the Law of One Price", Manchester School, 47-48 (1979-80).

38. Nordhaus, op. cit.

39. R.Z. Lawrence, "Towards a Better Understanding of Trade Balance Trends: the Cost-Price Puzzle", BPEA, (1979), 1. Also, Ormerod, op. cit.

40. M.C. Deppler and D.M. Ripley, quoted in P. Ormerod, op. cit.

41. Deppler and Ripley, quoted in Ormerod, op. cit.

42. Because of problems of degrees of freedom (footnote 27).

43. Deppler and Pipley, quoted in Ormerod, op. cit.

44. Ormerod, op. cit.; Lawrence, op. cit.

45. They hypothesis that the competitive price should be in domestic and not in foreign currency, was also tested; that is exporters respond in different ways to changes in world prices in foreign currency and to changes in the exchange rate. So the variable PWXG was split to its components, the competitors price in USA dollars (PWX) and the index of the exchange rate (ERI) (drachmae per USA dollar relative to the base year 1970) and the following equation was estimated by OLS corrected for a first order autocorrelation:

$$PXG_t = a_o + a_1 PGNPM_t + a_2 PWX_t + a_3 ERI_t + a_4 T + u_t$$

and the equality of the coefficients a_2 and a_3 was tested by the t test.

$$\frac{a_2 - a_3}{s_{a_2 - a_3}} \sim t_{n-k} \quad \text{where } s^2_{a_2} - a_3 = VAR(a_2) + VAR(a_3) - 2COV(a_2, a_3).$$

The null hypothesis of the equality $a_2 = a_3$ was accepted at the 5% level of significance, thus justifying the use of the competitors price in domestic currency in the estimation of the export price (see Ormerod, op. cit.).

9. THE FINANCIAL SECTOR

9.1 Introduction

Money is demanded because of its unique characteristic, that it is accepted as the universal means of exchange for goods and services[1].

Money is therefore necessary during transactions to effect payments. But the necessity of money in transactions is not a sufficient explanation for its demand. No income is normally derived from holding money. On the contrary one can lose income holding money, by incurring the loss of not buying an income earning asset. That is, one can buy an income earning asset at the time he is paid, and sell it again at the time he needs money to make payments.

This could be a rational process in a frictionless world. But in reality time is required and consequently costs are associated with the purchase and sale of assets. Moreover, it is not certain that the price of an asset at the time of its sale will be the same with the price for which it was bought and thus an element of risk is also involved.

To avoid the costs and possible losses associated with the timely purchase and sale of assets, which are necessary to satisfy the needs arising from transactions, the holding of money is desirable. In addition, no individual can be certain that his current receipts will balance his planned expenditure at every moment. Uncertainty may also exist about the timing of some transactions or, sometimes, obligations for some unexpected expenditures may arise. As a precaution against these needs the individual may again find preferable to hold money, which is easily acceptable in any transaction.

Another reason for which individuals may hold money, in apart from transactions purposes, is to benefit from the fluctuations in the price of income earning assets. Usually no income is earned from holding money, so that other assets are the most preferable way for holding wealth. But, because of the uncertainty concerning the future prices of different assets, individuals may expect that fluctuations in prices, in the future, may lead to capital losses. In this case (speculation on future prices), it would be better to hold money than incurring capital losses from holding other assets.

The aforementioned investigation into the motives of holding money has resulted in a large amount of theoretical work. Many theories of macroeconomic nature(2) have been expounded in an attempt to explain the demand for money.

9.2 Theories of the Demand for Money

9.2.1 The quantity theory of money

The first theory to explain the role of money in the exchange process, the quantity theory of money, was propounded by Irwin Fisher, and was based on the use of money for transactions. Starting from the fact that in every transaction there is a buyer and a seller, he has stated that, for the economy as a whole, the value of sales must be equal to the value of receipts.

At any time the value of sales is equal to the number of transactions multiplied by the average price level. On the other hand, the value of receipts equals the amount of money in circulation, times the average number of times it turns over in the same period. So, if M is the quantity of money, V is the number of times money circulates in a period of time, that is V is the transactions velocity of money, P is the average price level and T the volume of transactions, the proposition that the value of sales equals the value of receipts can be written as an identity in the form

9.2.1.1 $M * V = P * T$

Fisher, then postulating a full employment equilibrium level of income, assumed that there is a fixed ratio of the volume of transactions to the level of output and hence the volume of transactions (T) could be considered as constant. Furthermore assuming that

a) the volume of money (M) is independent from the other variables in the above identity (9.2.1.1) and so can be taken as given, and
b) the transactions velocity (V) rapidly converges after any disturbance to its equilibrium value and thus can be treated also as constant, he deduced that the price level depends on the quantity of money.

9.2.2 The Cambridge school approach

The Cambridge approach to the Quantity theory of money, instead of examining the forces determining the amount of money necessary for the transactions of an economy, emphasizes the desire for an individual to hold money. This approach tries to explain the forces which determine the amount of money any individual desires to hold.

This theory stresses the importance of alternative assets that one may choose to hold his wealth and the advantages they offer in comparison to money. Other assets, such as stocks and bonds, provide an income to its holders. Thus it will be of benefit to the individual to forfeit some of the convenience that money offers in the transactions, so that he may earn interest income. That is the demand for money depends not only on the planned volume of transactions of an individual, but also on the level of his wealth and the rate of interest which measures the opportunity cost of holding money instead of income earning assets.

Although it stressed the importance of these variables in determining the demand for money, the Cambridge school did not elaborate the interrelationships between them. Instead, postulating that in the short term a stable proportion exists between the level of wealth of an individual, his income, and the volume of transactions, it maintained(3) that, ceteris paribus, the demand for money is proportional to the level of income, both expressed in nominal terms. This resulted in a formulation similar to that of Fisher

9.2.2.1 $M^d = K * P * Y$

where M^d is the demand for money in nominal terms, P the average price level, Y real income and K the income velocity of money.

9.2.3 Keynes's approach

It was left to Keynes, in his general theory of employment interest and money, to develop the Cambridge approach analysing the different motives behind the demand for money. He distinguished three motives: the transactions, precautionary and the speculative motive. The transactions motive is confined to the regular and planned part of transactions. Under the precautionary motive he classified unexpected payments arising from such cases as emergencies (accidents, ill health), favourable price movements. He recognised, as Fisher and the Cambridge school, the importance of the transactions motive and maintained that the demand for money arising from the first two motives depends mainly on the level of income. At the same time Keynes suggested that the transactions and precautionary demand for money is also a function of the interest rate, as money can be exchanged for income earning assets.

But the main influence of the interest rate on the demand for money is attributed by Keynes to the speculative motive.

Assets of fixed nominal income per annum, like bonds, change their market value when the interest rate changes. A rise in the interest rate makes the market value of bonds fall, while it rises when the interest rate falls. Hence, movements in interest rates are the cause of capital gains or losses for those holding bonds. Thus bonds are particularly attractive because, in addition to the interest income, they give the opportunity of capital gains when the interest rate is expected to fall. The opposite situation, of capital losses, arises when the interest rate is expected to rise. Consequently, Keynes argued, the demand for money is at a low level when the interest rate is expected to fall, because people will hold bonds in expectation of capital gains. On the contrary money is demanded as bond holders try to shelter their wealth from capital losses, when they expect the interest rate to rise.

These movements of interest rates are based on the notion of the normal interest rate.

According to Keynes, there is a level of the interest rate regarded as normal. People compare the current interest rate with what they consider as its normal level; if the former is above this normal level they expect it to fall, giving them the opportunity of capital gains. Thus, they will hold bonds instead of demanding money. In the opposite case, when bond holders think that the current level of interest rate is below its normal level, they will expect it to rise with the consequence of capital losses. If these capital losses from bonds are expected to be larger than the interest income earned on bonds, they will substitute money for them.

For the economy as a whole, expectations about the rate of change of the current interest rate towards its normal level will vary. If the current level of interest rate is considered as low, people will expect it to rise and will prefer to have money. On the other hand, if the level of interest rate is considered high, people will expect it to fall, they will hold bonds and consequently the demand for money for speculation will be smaller. Hence, the speculative demand for money is a negative function of the current interest rate.

The aggregate demand for money then, originating from all the three motives in the short run, can be represented as

9.2.3.1 $$M^d = K * Y * P + \lambda (r)$$

where the first term in the right hand side of the equation (9.2.3.1), similar to that in (9.2.1.1) and (9.2.2.1), is nominal income and represents the effects of the transactions and precautionary motives, while the second term represents the effect of the speculative motive as a function of interest rate.

As mentioned above, the current interest rate is judged against what is considered as its normal level. Thus, if the current interest is at a considerably low level, everybody will expect it to rise and people will prefer either to hold money instead of bonds or to be indifferent. This is the case of the liquidity trap, where any increase in the quantity of money will not result in the fall in interest rates, that is at significantly low levels of interest rates, the elasticity of the aggregate demand for money with respect to interest rate can take the value of infinity. If this is the case, the liquidity trap hypothesis implies that the burden of managing the economy falls on fiscal measures as monetary policy becomes ineffective.

9.2.4 The modern approach to quantity theory of money

The modern quantity theory of money, for which the main contribution is by M. Friedman, is based not on the motives to hold money but on demand theory. Money, as any other form of assets, is considered as a source of services. The various factors which determine the amount which people will demand are analysed. Friedman considers wealth as the proper variable to play the role of the budget constraint in demand analysis.

Wealth is defined in broad terms so that it includes not only the stock of assets like durable goods, bonds, equities, but also human wealth defined as the present value of labour income. Because of the problems associated with the nature of human wealth, the non-human wealth could probably be employed as the constraint variable in the demand for money function. However, Friedman maintained his preference for a total wealth variable (including human wealth), and suggested that the ratio of human to non-human wealth should also be included in the equation, on the grounds that the higher the human wealth (to given total wealth) the larger the demand for money will be to make up for the lack of markets for human wealth.

By holding money one forfeits the income which other assets, like bonds or equities, offer. So, when the return from these assets rises they will be substituted for money whose demand will consequently fall. This return consists not only of the interest income, which the asset holder receives, but also from the capital gains (or losses) he incurs. As the price of these assets is inversely related to the market interest rate, the expected percentage change of this interest rate is used as the measure of the expected percentage change of capital gains (losses) from holding other assets. Because of the inverse relation between the price of assets and capital gains (losses) the percentage rate of change of the interest rate is subtracted from the rate of interest to arrive at the expected return of the asset, which people forfeit if they prefer to hold money.

Another variable considered as significant in the demand for money function, by the modern quantity theory, is the rate of change in prices. When prices rise the real value of money falls and vice versa. The expected rate of change of prices is then considered as the expected return of holding money and thus the higher the expected rate of change the lower will be the demand for money.

Lastly this theory is cast in real terms because money is a source of purchasing power. In order that the function for the demand for money be transformed to nominal terms, it should be multiplied through by the price level. So, finally the modern quantity theory of money can be presented as

9.2.4.1 $$M^d = f\left(W, h, r - \frac{1}{r}\frac{dr}{dt}, \frac{1}{p}\frac{dp}{dt}\right) P$$

where M^d is the demand for money is nominal terms, W is wealth, h represents the ratio of human to non-human wealth, r is the interest rate and p the price level. The time derivatives with respect to r and p indicate the expected rate of change of the interest rate and the price level respectively. In empirical implementations the permanent income has often been used in the place of the total wealth variable (4).

9.2.5 A transactions model of the demand for money

Drawing on the Keynesian analysis of the motives underlying the demand for money, theoretical work aimed at a rigorous study of the factors which determine it.

Analytical models were constructed to thoroughly examine the effects of the variables which influence the demand for money. The theoretical work on the demand for money stemming from the transactions motive is founded on the work of W. Baumol and J. Tobin(5). The main argument is that the transactions demand for money is not only associated with the volume of transactions but also inversely (negatively) related to the interest rate, because of the costs involved in trading cash for interest-income assets. As holding money involves the loss of the income that other assets (e.g. bonds) offer, an individual has to convert some of the assets he holds into cash to pay for his expenditures. But costs are involved in the transactions between cash and income yielding assets and thus the individual faces the problem of minimising those costs.

Stated in another way, an individual has an income equal to his transactions (T), which he holds in bonds (B) because of the income they yield, and he converts some of them into cash when he has to make payments. Let r be the interest rate that the individual forfeits by holding money and b the brokerage cost involved in changing bonds into cash; the brokerage cost is taken for simplicity to be independent of the value of each transaction.

Assuming that the individual spends the total income he receives at regular intervals his average cash holding over the period under examination will be $\frac{B}{2}$. Thus, every time he sells bonds, the total cost of a transactor consists of two parts. The one is due to the brokerage charges and equals $b\frac{T}{B}$, the other is due to the opportunity cost of holding money instead of income yielding bonds and equals $r\,\frac{B}{2}$, as $\frac{B}{2}$ is his average cash holding over the period.

The total cost C is then

9.2.5.1 $$C = b\,\frac{T}{B} + r\,\frac{B}{2}$$

To find the minimum cost of converting bonds into cash equation (9.2.5.1) is differentiated with respect to B and the resulting function is set equal to zero, giving

$$\frac{dC}{dB} = -\,b\,\frac{T}{B^2} + \frac{r}{2} = 0$$

and solving for B we derive

9.2.5.2 $$B = \sqrt{\frac{2bT}{r}}$$

As the value of the average cash holding over the period is $\frac{B}{2}$ the transactions demand for money is

$$M^d = \frac{B}{2} \quad \text{that is} \quad M^d = \frac{1}{2}\sqrt{\frac{2bT}{r}}$$

or rearranging the square root formula, the demand for money is

9.2.5.3 $$M^d = \sqrt{\frac{bT}{2r}}$$

By dividing the above equation by the price level we obtain

9.2.5.4 $$\frac{M^d}{P} = \sqrt{\frac{(\frac{b}{P})(\frac{T}{P})}{2r}}$$

that is the transaction demand for real money balances is proportional to the square root of the volume of transactions and inversely proportional to the square root of the interest rate.

9.2.6 The portfolio adjustment approach

In a more general structure the demand for money, which is regarded as one among various assets, is considered simultaneously with the demand for all other assets in a portfolio adjustment framework.

The financial system is highly complex, consisting of a large number of interrelated markets for many different assets and liabilities. Through these markets generally the various agents, government, banks, firms and the public supply and demand the various assets. Through the interaction of these supply and demand schedules of the different agents the quantity of the various assets and the price for each of them (the interest rates) are established.

Econometric models(6) usually incorporate a substantial and extensive financial sector. This sector of simultaneous equations usually contains several equations to account for the demand of currency, time and demand deposits, securities and loans. The aim is to establish the most important factors which determine the quantity demanded for each asset and efforts are made to identify the implications for the other sections of the economy. Among the variables which are considered as important in determining the demand for a particular asset are wealth or income, the interest rate of the asset in question and the returns of other assets regarded as close substitutes, and other exogenous variables such as reserves, the Central Bank discount rate, tax rates and government debt.

The supply side is usually accounted for by the equations which determine the different interest rates prevailing in the various asset markets. The main effort here is to estimate the long term interest rate, the term-structure equation, as a function of current and expected future values of the short term interest rate. Empirically, it is assumed that the expected future values of the short term interest rate can be measured adequately from its past values.

9.3 The Results of the Estimation of the Financial Equations

This study was not primarily aimed at estimating a complete and elaborate model of the financial sector of the Greek economy, which would require a more detailed analysis, nothwithstanding the problem of the availability of suitable and adequate data, and that of obtaining proper proxy variables. The main purpose of estimating equations for the financial sector in this model was to explain the financial variables and their effects on the real sector of the economy, in which they were employed.

Specifically, nominal money stock plus nominal total deposits, taken as a proxy for the value of liquid assets, were used in the consumption functions, while the change in the money stock was used in some of the price equations. On the other hand, the total amount of credits and the rate of interest for long term credits to industry were used as explanatory variables in the investment functions.

The equations estimated are demand functions for money (CUR), the flow of deposits (ΔDEP) and the flow of credits (ΔLO), while the supply of deposits and loans are accounted for by the equations which determine the rate of interest on bank deposits (RD) and the rate of interest on bank credits (RL). The money supply is considered as exogenous, fixed by the monetary authorities, and that it equals the demand for money.

The money variable (CUR) consists of total currency in circulation plus total sight deposits. Total deposits (DEP) is the sum of savings and time deposits with commercial banks and special credit institutions[7]. Total credits (LOAN) include the loans given both to the private and the public sector by all credit institutions. The data for currency, deposits and credits are given at the end of the year. Hence the average of the figures for two successive years were used for each of these variables in the estimated equations as their value for each period.

For bank deposits the interest rate of the savings deposits (RD) was used. The reason was that savings deposits are the largest part of deposits, exceeding fifty per cent and they often are around two thirds of total deposits. For bank credits, the interest rate for long term loans to industry (RL) was utilized which was also employed in the estimation of investment functions.

For all the above financial variables, the equations to be estimated are specified as long run equilibrium supply and demand models. The lagged dependent variable is also included to account for a partial adjustment mechanism as in previous sections of this study. That is, because of uncertainty, inertia and the costs involved in changes, and obtaining information individuals are assumed to adjust to the equilibrium level of, say, money demand, partially by some fraction, b, of the difference between the actual and desired (long-run) levels. The coefficient of adjustment (b) is constrained to be between zero and one.

9.4 The Money Equations

As stated above, the nominal value of liquid assets (money plus total deposits) was used as explanatory variable in consumption functions, and so the function for CUR was also estimated in nominal terms. The function estimated is of the type of the conventional money demand for transactions. Thus money stock is related to a measure of the transactions in the economy and to an interest rate variable which accounts for the opportunity cost of holding money instead of interest bearing assets(8) and hence a negative sign is expected for the coefficient of the interest rate variable as economic theory suggests (Section 9.2.5).

GNP is usually used as measure for the transactions in the economy, but its use presents some problems. In the calculations of GNP, transfers are ignored and transactions for intermediate goods and financial assets, which may result in demand for cash, are disregarded. On the other hand, GNP includes imputed items(9). Because of these shortcomings it was decided to use the value of total consumption expenditure (CV), as a measure for transactions, which reflects transfers and it is not so much affected by imputed items(10).

Because of the simultaneous determination of money and consumption expenditure, and in order to decrease these effects, the latter variable was included in the estimated equation lagged by one period (CV_{t-1})[11]. The interest paid by banks on savings deposits (RD) was used as the interest rate variable to account for the opportunity cost of holding money instead of income yielding assets. Thus the estimated equation was:

$$CUR_t = a_o + a_1 CV_{t-1} + a_2 RD_t + a_3 CUR_{t-1} + u_t$$

where $a_3 = (1-б)$ $0 \leq b \leq 1$, b is the adjustment coefficient and u_t is the error term which has zero expected value and constant variance.

The above equation was estimated by OLS, but the coefficient for the interest rate was statistically insignificant (the value of the t statistic was less than one) while the magnitude of the lagged dependent variable exceeded one (an inadmissible result as it violated the restriction that the adjustment coefficient lies between zero and one).

When RD was replaced by its lagged value RD_{t-1} there was a slight improvement (the value of the t statistic was greater than one), while the coefficient of the lagged dependent variable was again larger than one.

To allow for a more general lag structure the dependent variable lagged by two periods (CUR_{t-2}) was also included in the equation. The estimation showed that the equation for CUR was dominated by the two lagged dependent variables, which were the only ones statistically significant, as the results below show:

9.4.1
$$CUR_t = -\underset{(0.87)}{1361.57} + \underset{(1.38)}{0.0558}CV_{t-1} - \underset{(0.57)}{151.566}RD_{t-1} + \underset{(6.22)}{1.586}CUR_{t-1} - \underset{(2.96)}{0.697}CUR_{t-2}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.59 INC. SEE = 1560.88

Although both the coefficients of the lagged dependent variables (CUR_{t-1}) and (CUR_{t-2}) are statistically significant, their signs alternate from positive to negative and the magnitude of the coefficient for CUR_{t-1} exceeds one. They, thus indicate that differencing these variables could be appropriate. Hence the lagged dependent variables CUR_{t-1} and CUR_{t-2} were replaced by their first difference (ΔCUR_{t-1})(12) and the equation was re-estimated by OLS with the following results:(13)

9.4.2
$$CUR_t = -\underset{(1.04)}{2827.22} + \underset{(15.30)}{0.296}CV_{t-1} - \underset{(2.62)}{1027.71}RD_{t-1} + \underset{(2.30)}{0.9341}\Delta CUR_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 0.87 POS. SEE = 2731.0

Because the value of the Durbin-Watson statistic indicates the existence of positive autocorrelation in the residuals, the above equation was estimated by generalised least squares with a first order autocorrelation process. This resulted in

9.4.3
$$CUR_t = \underset{(0.64)}{4537.25} + \underset{(14.20)}{0.2746}CV_{t-1} - \underset{(1.40)}{625.722}RD_{t-1} + \underset{(2.15)}{0.6938}\Delta CUR_{t-1} \qquad \rho = \underset{(9.46)}{0.90}$$

$R^2 = 0.97$ $\bar{R}^2 = 0.97$ DW = 1.83 N.A. SEE = 2089.34

As the portfolio adjustment approach suggests (Section 9.2.6) the demand for money, as of any other asset is influenced by the returns of other assets regarded as closed substitutes. Thus, in addition to RD (the interest rate on deposits) it was decided to introduce in the equation the effect of the demand of alternative assets in apart from deposits. Because of the uncertainty for the suitable yield variable and the lack of sufficient data on the one hand, and on the other taking into consideration the extent of government's intervention and involvement (government controlled banks) and hence its ability, to a certain extent, to influence the course of the economy by fiscal and monetary measures, it was decided to use the discount rate of the bank of Greece (DIRA) as a proxy for the yields of alternative assets.

By managing the magnitude of DIRA government can exercise a strong influence of the movements of other yields. As mentioned earlier economic theory suggests that an increase in the yield of alternative assets regarded as closed substitutes, will, ceteris paribus, reduce the demand for money and thus the expected sign of DIRA would be negative. DIRA was included in equation (9.4.2) which was estimated by generalised least squares with a first order autocorrelation process. But its coefficient had a positive sign and was also statistically insignificant and was thus dropped from the equation.

The inclusion of the rate of change of the consumer price index $\left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}\right)$ as a proxy for expected inflation, produced an insignificant coefficient with the wrong (positive) sign. (The demand for money could be reduced because people expecting a higher rate of inflation will turn to other forms of assets of greater security.)

The consumer price index (CPI) which was used to represent the effects of the price level on the demand for money, although it had the correct (positive) sign (as an increase in the price level could increase the transaction demand for money), was statistically insignificant (the value of the t statistic was less then one) as the results below show

$$CUR_t = \underset{(0.10)}{893.88} + \underset{(6.41)}{0.25CV_{t-1}} - \underset{(1.53)}{728.42RD_{t-1}}$$

$$+ \underset{(0.71)}{93.69CPI_t} + \underset{(1.52)}{0.566\Delta CUR_{t-1}} \qquad \underset{(9.46)}{\rho = 0.90}$$

$R^2 = 0.97 \quad \bar{R}^2 = 0.97 \quad DW = 1.78$ N.A. $\quad SEE = 2120.04$

Using instead of CPI the lagged consumer price index (CPI_{t-1}) resulted in a coefficient with statistically insignificant and wrong (negative) sign for the price variable.

It was thus decided to retain in the model the equation (9.4.3). The coefficients of the equation have the expected signs and the main influence is exercised by the variable which captures the transaction effects (CV), while the interest rate variables, which were employed in the equation, do not exercise an important influence in the demand for money (they were statistically insignificant) and the interest rate on deposits, retained in the equation, has a mild effect on the demand for money.

9.5 The Equations for the Demand for Deposits and Loans

In these simple models for the demand for the flow in total deposits (ΔDEP) and total credits (ΔLO), it is considered plausible to assume that, on the one hand the main constraint on the behaviour of individuals and business to increase the flow of deposits is the amount of income at the disposal of the public(14). On the other hand, it is assumed that the flow of total loans (ΔLO) is geared to the short and long run need of financing production (whether to increase capital stock (investment) or consumption, exports etc). Thus both the flow of deposits (ΔDEP) and credits (ΔLO) are functions of the current value of GNP and are positively related to it. In addition deposits will positively depend on the rate of interest (RD) offered by the financial institutions to attract them, while loans will be negatively influenced by interest charges (RL) that borrowers have to pay, in order to obtain loans.

As in the case for the demand for currency (CUR) no attempt was made, as it is proper from theoretical point of view(15), to use a proxy for wealth as an explanatory variable in the remaining equations determining the financial variables of the model, because of the lack of suitable data.

Because of the simultaneity effects between the flow of deposits and credits and the value of GNP, the latter variable lagged by one period ($GNPV_{t-1}$) was included in the estimated equations(16). This decision was also supported by the estimates of equations for ΔDEP and ΔLO (of the same specification) which showed that the magnitude of the coefficients of $GNPV_t$ and $GNPV_{t-1}$

were very similar (for ΔDEP equation the coefficient for $GNPV_t$ was 0.065 while for $GNPV_{t-1}$ was 0.063. For ΔLO equation the magnitude of the coefficients was 0.053 and 0.046 respectively).

In addition some equations, which were estimated with the Almon's polynomial technique (second degree polynomials with five periods and no end restrictions), indicated that, in both the equations for ΔDEP and ΔLO, $GNPV_t$ has a negative sign, and in the equation for the flow of loans was also statistically insignificant. A small sample of these equations is shown below (figures in brackets are absolute t values except when otherwise stated).

$$\Delta DEP = \underset{(1.68)}{-\ 14945.3} - \underset{(1.17)}{611.6RD_t} + \sum_{i=0}^{4} a_i GNPV_{t-i}$$

$$a_o = -\ 0.234\ (2.50)$$

$$a_1 = 0.146\ (3.28)$$

$$a_2 = 0.274\ (2.96)$$

$$a_3 = 0.109\ (1.34)$$

$$a_4 = -\ 0.182\ (1.54)$$

$$\sum_{i=0}^{4} a_i = 0.113 \qquad \text{Mean lag} = 1.473$$

St. dev (0.327) St. dev (1.835)

$$\Delta LO = \underset{(0.06)}{532.29} - \underset{(0.76)}{757.2RL_t} + \sum_{i=0}^{4} a_i GNPV_{t-i}$$

$a_o = -\ 0.114\ (1.94)$

$a_1 = \ \ 0.076\ (2.83)$

$a_2 = \ \ 0.138\ (4.37)$

$a_3 = \ \ 0.07\ \ (2.25)$

$a_4 = -\ 0.126\ (2.09)$

$\sum_{i=0}^{4} a_i = 0.044$ Mean lag = 1.33

St. dev (0.139) St. dev (64.81)

$$\Delta LO = -\underset{(0.43)}{982.718} - \underset{(1.16)}{1021.46\Delta RL_t} + \sum_{i=0}^{4} a_i \Delta GNPV_{t-i}$$

$a_o = -\ 0.093\ (1.88)$

$a_1 = \ \ 0.066\ (1.46)$

$a_2 = \ \ 0.131\ (2.60)$

$a_3 = \ \ 0.101\ (2.63)$

$a_4 = -\ 0.023\ (0.72)$

$\sum_{i=0}^{4} a_i = 0.181$ Mean lag = 2.964

St. dev (0.169) St. dev (3.45)

The results obtained by using the Almon technique are mentioned only as an indication. Reliable estimates using this technique would require extensive experimentation with polynomials of different degrees, varying the length of lags, and investigating the effects of end restrictions. But this was precluded because of the shortage of degrees of freedom and the multicollinearity in the data.

Thus the following equation for the flow of deposits was estimated by OLS

$$9.5.1 \qquad \Delta DEP = a_o + a_1 GNPV_{t-1} + a_2 RD_t + a_3 \Delta DEP_{t-1} + u_t$$

(where GNPV is the nominal gross national product at factor cost), and gave the following results

$$9.5.2 \qquad \Delta DEP = \underset{(1.77)}{-\ 6433.79} + \underset{(3.39)}{0.0647} GNPV_{t-1} + \underset{(0.25)}{157.47} RD_t + \underset{(2.56)}{0.532} \Delta DEP_{t-1}$$

$$R^2 = 0.97 \quad \bar{R}^2 = 0.96 \quad DW = 1.59 \text{ N.A.} \quad SEE = 4231.73$$

Although the coefficients have the expected signs (as explained above) and the summary statistics ($\bar{R}^2$, DW) are satisfactory, the interest rate variable is statistically zero. Because the value of the Durbin-Watson statistic is low (though in the non-autocorrelation region) the above equation was also estimated by generalised least squares for a first order autocorrelation. The estimation proved the existence of positive autocorrelation in the residuals, as the relevant coefficient ρ had a magnitude of 0.75 and was statistically significant, while the coefficient of the interest rate became negative. The interest rate lagged by one period (RD_{t-1}) was then included in the above equation, instead of RD_t, and the estimation showed that this variable RD_{t-1} had not only the correct positive sign but was also statistically significant, while the estimation by generalised least squares corroborated the absence of significant first order autocorrelation in the residuals. The results of both these estimation (by OLS and GLS) are shown below:

9.5.3
$$\Delta DEP_t = -\underset{(3.89)}{12581.0} + \underset{(3.77)}{0.0589}GNPV_{t-1} + \underset{(2.52)}{1308.77}RD_{t-1} + \underset{(3.22)}{0.558}\Delta DEP_{t-1}$$

$R^2 = 0.98$ $\bar{R}^2 = 0.97$ DW = 1.61 N.A. SEE = 3641.25

9.5.4
$$\Delta DEP = -\underset{(3.63)}{14078.0} + \underset{(3.53)}{0.0629}GNPV_{t-1} + \underset{(2.32)}{1512.85}RD_{t-1} + \underset{(2.70)}{0.503}\Delta DEP_{t-1} \qquad \rho = \underset{(1.18)}{0.25}$$

$R^2 = 0.96$ $\bar{R}^2 = 0.96$ DW = 1.66 N.A. SEE = 3654.94

The inclusion of the dummy variable (D74) had an important effect on deposits; its coefficient had a large magnitude and was statistically significant, as the following results show (OLS estimation):

9.5.5
$$\Delta DEP = -\underset{(5.72)}{13571.9} + \underset{(6.45)}{0.0833}GNPV_{t-1} + \underset{(3.03)}{1153.44}RD_{t-1} + \underset{(2.27)}{0.318}\Delta DEP_{t-1} - \underset{(4.07)}{12636.0}D74$$

$R^2 = 0.99$ $\bar{R}^2 = 0.98$ DW = 2.01 N.A. SEE = 2664.03

The inclusion of D74 not only was significant in itself but also reduced the standard errors of both the explanatory variables $GNPV_{t-1}$ and RD_{t-1} and especially of the former for which the value of the t statistic increased from 3.77 in equation (9.5.3) to 6.45; at the same time the value of the Durbin-Watson statistic increased from 1.61 to 2.01 showing that the absence of the dummy variable from the estimated equation was the cause of the low value of the Durbin-Watson statistic.

In an attempt to assess the effects of the yield of other assets on deposits, the discount rate (DIRA) was also included in the equation as a proxy for the alternative yield to that of deposits, which individuals could obtain by substituting other assets for them. As an increase in the yield from other assets will, ceteris paribus, result in substituting these assets for deposits, a negative sign is expected for the coefficient of the proxy variable (DIRA). The results of OLS estimation, given below, showed that the coefficient of DIRA had the expected negative sign, but was statistically insignificant, the value of the t statistic slightly exceeding one.

Notwithstanding its insignificance DIRA was retained, because a suitable variable should be included in the equation to represent, even inadequately, the effects of the yield from alternative assets[17]:

9.5.6 $$\Delta DEP_t = \underset{(4.63)}{-\ 12321.3} + \underset{(3.44)}{0.06794}GNPV_{t-1} + \underset{(2.10)}{2115.44}RD_{t-1}$$

$$- \underset{(1.03)}{798.373}DIRA + \underset{(2.25)}{0.489}\Delta DEP_{t-1} - \underset{(2.05)}{9246.88}D74$$

$R^2 = 0.99$ $\bar{R}^2 = 0.98$ DW = 1.99 N.A. SEE = 2658.79

The variables of this equation have the expected signs and are statistically significant (except DIRA) while its summary statistics are equally satisfactory as those of equation (9.5.5). Thus the equation (9.5.6) was retained in the model.

In estimating the equation for the demand of the flow of total bank credits (ΔLO) it was not possible to establish a statistically significant relation between the flow of credits and the interest rate of long term credits to industry, RL. (The interest rate which was also used in the investment functions.)

Both the current (RL) and the one period lagged interest rate (RL_{t-1}), when alternatively included, were statistically insignificant (the value of the t statistic was less than one) while the RL_{t-1} had always a wrong, positive, sign while a negative sign for the reasons stated earlier was expected. Although the insignificance of the interest rate on loans could be attributed to the limited variation of this variable in the sample period, it should be also noted that RL may be an inadequate measure of the interest rate charges on total loans, as it is applied to long term credits for industry, a relatively small part of total credits.

The value of investment and the value of inventories were also included in the equation instead of GNPV, their effect on the demand for loans being positive as theoretical work on financial sector models has indicated(18), but they were statistically insignificant (value of t less than one), while inventories have a negative sign.

It should be also mentioned that the equation for loans was also estimated by the Almon's polynomial technique, in which the interest rate(RL) was constrained on a third degree polynomial with five periods and no end restrictions. The results showed that all five terms of RL were statistically insignificant (the highest value for the t statistic being 0.76) and have had positive signs (only one term had a negative sign).

The estimation of the equation for loans in a first difference form, produced coefficients for both the ΔGNPV and ΔRL variables which have wrong signs.

Only the time trend had a mildly significant coefficient, and thus the following equation, estimated by OLS, was retained in the model(19) (the estimates by generalised least squares and 2SLS were very close to those below):

9.5.7 $$\Delta LO_t = \underset{(0.05)}{-\,242.262} + \underset{(2.78)}{0.0674GNPV_{t-1}} - \underset{(0.47)}{225.03RL_t} - \underset{(1.96)}{394.181T} + \underset{(4.23)}{0.771\Delta LO_{t-1}}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.80 N.A. SEE = 1756.62

9.6 The Results of the Interest Rates Functions

The supply functions for total deposits and credits are accounted for by the functions which determine the interest rate on bank deposits (RD) and the interest rate on long term credits to industry (RL) respectively.

Banking activities are regulated by government, and control over their operations is exercised by the monetary authorities; one of their main instruments to influence banking activities is the manipulation of the discount rate (DIRA).

It is thus postulated that both interest rates are ultimately dependent on the discount rate. It is also plausible to assume that individuals and banks are interested in the real yields of the deposits and credits they supply, and thus the expected movements in prices might influence the interest rates[20]. In this study the rate of change in the consumer price index ($\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$) was used as a proxy for the expected movements in prices.

The amount of credits that banks and financial institutions supply depends, among other conditions, on total deposits, whose costs for the banks (RD) could result in increasing the level of the interest rate (RL) which is charged for their credits to public. Hence, RD was also included as an argument in the function which determines the long term interest rate on credits to industry (RL) and a positive coefficient is expected. Including the lag dependent variable in each function (21) (to account for adjustment delays between the actual and the desired level of interest rates), the two estimated equations for RD and RL were

9.6.1 $$RD_t = a_o + a_1 DIRA_t + a_2 \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + a_3 RD_{t-1}$$

9.6.2 $$RL_t = b_o + b_1 RD_t + b_2 DIRA_t + b_3 \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + b_4 RL_{t-1}$$

The estimates for RD (9.6.1) by ordinary least squares (the generalised least squares estimates indicated the absence of first order autocorrelation in the residuals as the autocorrelation coefficient was statistically zero) were:

9.6.3 $$RD_t = \underset{(2.15)}{1.3253} + \underset{(2.78)}{0.3317}DIRA_t + \underset{(3.17)}{0.0754} \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + \underset{(1.93)}{0.318}RD_{t-1}$$

$R^2 = 0.83$ $\bar{R}^2 = 0.81$ DW = 1.83 N.A. SEE = 0.718

while those by 2SLS (to allow for simultaneity effects) below were almost similar

9.6.4 $$RD_t = \underset{(2.17)}{1.3373} + \underset{(2.71)}{0.3256}DIRA_t + \underset{(3.13)}{0.080} \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + \underset{(1.94)}{0.3199}RD_{t-1}$$

DW = 1.84 N.A. SEE = 0.7188

When the consumer price index (CPI) or its one period lag (CPI_{t-1}) were included in the equation (9.6.3), instead of the rate of change of CPI, the results were inferior. Not only were the summary statistics worse (the $\bar{R}^2$ decreased to 0.71 and the Durbin-Watson statistic was inconclusive) but the coefficients of CPI and CPI_{t-1} had a very small effect on RD (compared to that of the rate of change in CPI) and were statistically insignificant (the value of the t statistic was 1.16 for CPI and 0.70 for CPI_{t-1}), while the rate of change of CPI lagged by one year resulted in inferior fitting of the equation (lower $\bar{R}^2$). To test the hypothesis that the composition of banks portfolios affects the deposits interest rate, the ratio of loans to deposits($\frac{LO}{DEP}$) was included in the equation. The results indicated that this hypothesis could not be supported as the coefficient of the variable $\frac{LO}{DEP}$ was statistically insignificant (the value of the t statistic was less than one) although it had the expected positive sign[22].

The exclusion of the expected price variable $(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}})$ from equation (9.6.3) led to the determination of the results as the $\bar{R}^2$ decreased to 0.71, while the Durbin-Watson statistic was inconclusive (1.31). Hence, the above equation (9.6.4), estimated by 2SLS, was selected for the determination of the interest rate on bank deposits (RD).

The estimation by OLS of equation (9.6.2), for the long term interest rate of bank credits to industry (RL), gave the following results:

$$9.6.5 \qquad RL_t = \underset{(3.84)}{1.9315} + \underset{(5.05)}{0.453}RD_t + \underset{(0.25)}{0.0184}DIRA_t + \underset{(2.86)}{0.0347} \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + \underset{(3.83)}{0.391}RL_{t-1}$$

$$R^2 = 0.96 \qquad \bar{R}^2 = 0.95 \qquad DW = 1.50 \text{ INC.} \qquad SEE = 0.3044$$

As the Durbin-Watson statistic is in the inconclusive region, the above equation (9.6.5) was re-estimated for a first order autocorrelation process and resulted in:

$$9.6.6 \qquad RL_t = \underset{(3.64)}{2.2572} + \underset{(5.33)}{0.4123}RD_t + \underset{(2.43)}{0.1886}DIRA_t + \underset{(1.42)}{0.019} \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + \underset{(2.55)}{0.2459}RL_{t-1} \qquad \rho = \underset{(3.08)}{0.55}$$

$$R^2 = 0.91 \qquad \bar{R}^2 = 0.90 \qquad DW = 1.96 \text{ N.A.} \qquad SEE = 0.2714$$

Excluding from the right hand side of the above equation the interest rates explanatory variables (RD) and (DIRA), one at a time, gave inferior results. But as it can be observed from the following results, estimated by ordinary least squares[23], the interest rate on bank deposits (RD) has had considerably more explanatory power than the discount rate (DIRA) for the equation determining the long term interest rate for credits to industry (RL)

$$9.6.7 \qquad RL_t = \underset{(3.37)}{2.496} + \underset{(2.31)}{0.2158} DIRA_t + \underset{(4.46)}{0.0683} \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + \underset{(3.00)}{0.46} RL_{t-1}$$

$R^2 = 0.90 \quad \bar{R}^2 = 0.89 \quad DW = 1.61$ N.A. $\quad SEE = 0.4608$

$$9.6.8 \qquad RL_t = \underset{(4.00)}{1.711} + \underset{(6.21)}{0.453} RD_t + \underset{(2.89)}{0.035} \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + \underset{(5.53)}{0.44} RL_{t-1}$$

$R^2 = 0.94 \quad \bar{R}^2 = 0.93 \quad DW = 1.73$ N.A. $\quad SEE = 0.3213$

In the equation including only RD, the fit (measured by $\bar{R}^2$) is higher, while there is a considerable reduction in the standard error of estimate from 0.46 in the equation with DIRA to 0.32 in that with RD.

Furthermore, dropping from the equation (9.6.8) the variable $\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$ did not deteriorate the fit of the equation, but increased slightly the standard error of estimate to 0.35 while, more importantly, the value of the Durbin-Watson statistic decreased to the low level of 1.15 (inconclusive).

The exclusion of the same variable $(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}})$ from equation (9.6.6) did not lead to any significant changes in the same statistical properties of the equation (regarding the significance of the coefficients and the summary statistics). However this variable was kept because, as inflation expectations influence the interest rate, a suitable variable may be included in the equation. On the other hand, though statistically insignificant, the value of the t statistic of the coefficient of $\frac{CP_t - CPI_{t-1}}{CPI_{t-1}}$ exceeds one.

It should be noted that inserting in the equations (9.6.6) and (9.6.8) the change in CPI lagged by one year, instead of $\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$, resulted in lower $\bar{R}^2$ for both equations.

According to economic theory, the desired interest rate on loans could be positively influenced by the composition of bank portfolios[24] (as in the interest rate on deposits), and thus the variable $\frac{LO}{DEP}$ was also tried in various estimated equations for RL. But this hypothesis (influence of the composition of basic portfolios) could not be supported by the results. The coefficients of the variable $\frac{LO}{DEP}$ was statistically insignificant, while it often had a negative sign.

The equation (9.6.5) was also estimated by the procedure of 2SLS, but because of the low value of the Durbin-Watson statistic (1.47 inconclusive), the equation (9.6.6) with a first order autocorrelation correction was preferred.

Finally, both the equations (9.6.6) and (9.6.8) satisfy the criteria usually employed, (variables suggested by economic theory, correct signs, significant coefficients and satisfactory summary statistics), the former having a lower standard error of estimate, and the latter having a better fit. The Durbin-Watson statistic indicates the absence of first order autocorrelation in the residuals (1.96 for equation (9.6.6) and 1.73 for the latter).

In addition, before choosing between them, it was decided to examine how closely they forecast the movements of RL outside the sample period. Forecasts for four years (1978-1981) were generated and the root mean square percentage error (RMSPE) and the $Z_1(k)$ statistic were calculated. For both equations the hypothesis of forecasting accuracy, measured by the $Z_1(k)$ statistic was rejected. (The critical value with four degrees of freedom is 9.488.)

The value of the $Z_1(k)$ statistic was 135.004 for the equation (9.6.8), while for (9.6.6) the value of $Z_1(k)$ statistic decreased considerably to 39.396, although still far in excess of the critical one. The same relative difference in favour of the forecasting power of equation (9.6.6) was also observed in the magnitude of RMSPE. The value of RMSPE for the equation (9.6.6) was 5%, while for (9.6.8) was doubled to the figure of 10.2%. Hence, taking also into consideration these results, it was decided to retain in the model the equation (9.6.6) for the determination of the interest rate of long term credits to industry (RL).

Summarising, the following equations have been retained in the model to explain the financial variables:

9.4.3

$$CUR_t = \underset{(0.64)}{4537.25} + \underset{(14.20)}{0.2746}CV_{t-1} - \underset{(1.40)}{625.722}RD_{t-1} + \underset{(2.15)}{0.6938}\Delta CUR_{t-1} \qquad \rho = \underset{(9.46)}{0.90}$$

$R^2 = 0.97$ $\bar{R}^2 = 0.97$ DW = 1.83 N.A. SEE = 2089.34

9.5.6

$$\Delta DEP_t = -\underset{((4.63)}{12321.3} + \underset{(3.44)}{0.06794}GNPV_{t-1} + \underset{(2.10)}{2115.44}RD_{t-1} - \underset{(1.03)}{798.373}DIRA_t + \underset{(2.25)}{0.489}\Delta DEP_{t-1} - \underset{(2.05)}{9246.88}D74$$

$R^2 = 0.99$ $\bar{R}^2 = 0.98$ DW = 1.99 N.A. SEE = 2658.79

9.5.7

$$\Delta LO_t = -\underset{(0.05)}{242.262} + \underset{(2.78)}{0.0674}GNPV_{t-1} - \underset{(0.47)}{225.03}RL_t - \underset{(1.96)}{394.181}T + \underset{(4.23)}{0.771}\Delta LO_{t-1}$$

$R^2 = 0.99$ $\bar{R}^2 = 0.99$ DW = 1.80 N.A. SEE = 1756.62

9.6.4

$$RD_t = \underset{(2.17)}{1.3373} + \underset{(2.71)}{0.3256}DIRA_t + \underset{(3.13)}{0.080}\ \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + \underset{(1.94)}{0.3199}RD_{t-1}$$

DW = 1.84 N.A. SEE = 0.7188

9.6.6

$$RL_t = \underset{(3.64)}{2.2572} + \underset{(5.33)}{0.4123}RD_t + \underset{(2.43)}{0.1886}DIRA_t + \underset{(1.42)}{0.019}\ \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \times 100 + \underset{(2.55)}{0.2459}RL_{t-1} \qquad \rho = \underset{(3.08)}{0.55}$$

$R^2 = 0.91$ $\bar{R}^2 = 0.90$ DW = 1.96 N.A. SEE = 0.2714

From the above equations the mean lags (ML) and the short and long run elasticities were calculated. The interest rates functions have very short mean lags (around a half or a third of a year), being 0.47 (about five and a half months) for the equation for RD and 0.33 for the RL equation (about four months).

For the flow of deposits equation, the mean lag is almost one year (ML = 0.96), while the flow of loans equation has a rather long mean lag of slightly less than three and a half years (ML = 3.37).

The short run elasticity of money (CUR) with respect to interest rate (RD) is -0.08, while that with respect to transactions variable (CV_{t-1}) of 1.03 seems rather large. As it can be seen from the equations (9.4.1) and (9.4.2), the coefficient of CV_{t-1} increased from 0.056 in the former to 0.27 in the latter when the transformation ΔCUR_{t-1} was used. (As an indication, the magnitude of the elasticity 0.21 of the equation (9.4.1) is mentioned.) In addition, the magnitude of this elasticity is considerably smaller in other models (with respect to the same variable)[25].

The short and long run elasticities of the rest of the financial variables are reported in the following tables[26]. The elasticity of interest rates with respect to the rate of change of the consumer price index $\left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}\right)$ were negligible and so they are not included[27]:

Short-run Elasticities	With respect to				
	$GNPV_{t-1}$	RD_t	RD_{t-1}	RL_t	$DIRA_t$
ΔDEP	0.96		0.82		-0.39
ΔLO	0.73			-0.09	
RD					0.43
RL		0.31			0.18

Long-run Elasticities	With respect to				
	$GNPV_{t-1}$	RD_t	RD_{t-1}	RL_t	$DIRA_t$
ΔDEP	1.87		1.60		-0.76
ΔLO	3.19			-0.39	
RD					0.60
RL		0.41			0.23

Forecasts were generated by the above preferred equations for the next four years, 1978-1981, and the results are presented in the tables below, together with the actual figures and the deviations of the latter from the former (all the variables are in billion drs).

	Stock of Money CUR			Flow of Deposits ΔDEP			Flow of Credits ΔLO		
	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations
1978	207.8	204.6	-3.2	99.4	91.3	-8.1	111.3	121.3	10.0
1979	246.7	234.7	-12.0	107.9	111.3	3.4	124.3	143.2	18.9
1980	288.8	287.1	-1.7	133.1	135.4	2.3	158.4	168.1	9.7
1981	347.2	343.8	-3.4	233.9	172.0	-61.9	241.1	213.0	-28.1
Sum of Absolute Deviations			20.3			75.7			66.7

	Stock of Deposits DEP		Stock of Credits LO	
	Actual	Forecasts	Actual	Forecasts
1978	473.3	465.2	606.5	616.4
1979	581.3	584.6	730.8	749.6
1980	714.4	716.6	889.2	898.9
1981	948.3	886.4	1130.3	1102.2

	Interest Rate on Bank Deposits RD			Interest Rate on Bank Credits RL		
	Actual	Forecasts	Deviations	Actual	Forecasts	Deviations
1978	7.75	8.88	1.13	11.00	10.77	-0.23
1979	10.75	10.67	-0.08	13.00	13.03	0.03
1980	13.50	13.33	-0.17	16.75	15.31	-1.44
1981	13.50	14.32	0.82	18.00	17.12	-0.88
Sum of Absolute Errors			2.20			2.58

The hypothesis of the constancy of the parameters outside the sample period (forecasting accuracy) is rejected for all the above variables except the one for RD.

The calculated value of the $Z_1(k)$ statistic (the critical value with four degrees of freedom (k) being 9.488 from the χ^2 tables) is 37.438 for the money variable (CUR), 553.120 for the flow of deposits (ΔDEP), 433.546 for the flow of credits (ΔLO), and 39.396 for the long term interest rate on bank credits (RL). For the interest rate on bank deposits (RD) the value of the $Z_1(k)$ statistic is 3.888.

The forecasting error of the equation for the flow of loans, as the above tables show is for almost all years considerably larger, compared with that of the equations for ΔDEP and CUR. The two flow equations (ΔDEP and ΔLO) underpredict by a large margin the significant increase in the flow of deposits and loans for 1981, particularly the equation for deposits. When the observation for 1981 was dropped, the value of the $Z_1(k)$ statistic for ΔDEP decreased from 553.120 to 11.486, although still in excess of the critical one (9.488).

In the following tables the root mean square percentage error (RMSPE) and the root mean square error (RMSE) are reported:

	RMSE billion drs	RMSPE %
CUR	6.4	2.6
ΔDEP	31.3	14.0
ΔLO	18.3	11.0

	RMSE	RMSPE
RD	0.70	8.0
RL	0.85	5.0

The RMSE and RMSPE were also calculated for the equations for ΔDEP and ΔLO, by dropping the observation for 1981. There was a small decrease for the loan equation to 13.5 billion drs in the RMSE and to 10.7% in the RMSPE. But for the equation for deposits the omission of the figure for 1981 resulted in a considerable improvement. The RMSE decreased from 31.3 billion drs to 5.2 billion and the RMSPE from 14% to 5.1%.

The figures of the RMSE and RMSPE indicate that the equations forecast quite satisfactorily outside the sample period (the equation for deposits for three years), except for the equation for the flow of loans, which overpredicts, for the first three years and underpredicts for 1981, the actual credits by quite large errors. As it has been shown, the equation indicates that the long term interest rate (RL) included in the equation is not the proper one to account for bank charges on total loans.

FOOTNOTES TO CHAPTER NINE

1. D.E.W. Laidler, The Demand for Money, 1977, p.51.

2. This brief account of the theories for holding money concerns those taking an aggregate approach. Thus, theories based explicity on each particular motive for holding money will not be considered; consequently the effect of other important factors on holding money (such as income distribution, risks) has been ignorned.

3. Laidler, op. cit.

4. M. Friedman, "The Demand for Money: Some Theoretical and Empirical Results", Journal of Political Economy, 67 (1959); F. de Leeuw, "A Model of Financial Behaviour", in The Brookings Quarterly Econometric Model of the United States , J.S. Duesenberry, G. Fromm, L.R. Klein, E. Kuh eds., 1965; J.A. Trevithick and C. Mulvey, The Economics of Inflation, 1975, p.128.

5. J. Tobin, "The Interest-Elasticity of Transactions Demand for Cash", Review of Economics and Statistics, 38 (1956).

6. De Leeuw, op. cit.; F. de Leeuw and E. Gramlich, "The Federal Reserve MIT Econometric Model" Federal Reserve Bulletin, 54 (1968); P.H. Hendershott, "Recent Developments of the Financial Sector of Econometric Models", Journal of Finance, 23 (1968).

7. Deposits in foreign exchange are not included because of their different legal status and the terms applying to them.

8. The transactions motive relates money stock to the flow of income; see G.C. Chow, "On the Long-Run and Short-Run Demand for Money", Journal of Political Economy, 74/2 (1966) p.127. For the relationship between interest rate and the transactions demand for money, see Tobin, op. cit.; S.M. Goldfeld, "The Case of the Missing Money", Brookings Paper on Economic Activity (1976), 3; D.K. Marothia and W.E. Phillips, "Demand and Supply Functions for Money in Canada", Journal of Monetary Economics, 9 (1982).

9. Goldfeld, op. cit.

10. The value of consumption expenditure is used in the equation determining currency in the model by F. de Leeuw and E. Gramlich, op. cit. In the London Business School Model.the value of consumption of non-durables is used in the equation for currency; see J.L. Waelbroeck ed., The Models of Project Link, 1976.

11. See M. Feldstein, "Inflation, Tax Rules and Investment: Some Econometric Evidence", Econometrica 50 (1982), p.839.

12. See P. Ormerod, "Manufactured Export Prices in the U.K. and the 'law of one price'", Manchester School, 47-48 (1979-1980).

13. The value of the current period consumption expenditure (CV) was also used instead of CV_{t-1}. But the coefficients had almost similar magnitude (0.27 for CV and 0.29 for CV_{t-1}).

14. De Leeuw, op. cit.; De Leeuw and Gramlich, op. cit.; S.M. Goldfeld, "An Extension of the Monetary Sector", in The Brookings Model: Some Further Results, J.S. Duesenberry, G. Fromm, L.R. Klein, E. Kuh eds., 1969.

15. De Leeuw, op. cit.

16. Feldstein, op. cit.

17. See models in: De Leeuw, op. cit., De Leeuw and Gramlich, op. cit. and Hendershott, op. cit.

18. Hendershott, op. cit.

19. The dummy variable (D74), when included in the demand for loans equation was statistically significant but resulted in a positive coefficient for the interest rate variable (RL) and subsequently it was not further employed.

20. A. Ando and F. Modigliani, "Some Reflections on Describing Structures of Financial Assets", in The Brookings Model: Perspective and Recent Developments, G. Fromm and L.R. Klein eds., 1975.

21. It is assumed that banks have a desired (long-run) level for both RD and RL, which depends on the above mentioned variables for each of them. They adjust slowly to the desired level for various reasons, such as informational costs, uncertainty, institutional factors.

22. Hendershott, op. cit. pp. 49-52.

23. The estimation by generalised least squares of these equations showed that, in both, the autocorrelation coefficient is statistically insignificant (t statistic less than one).

24. Hendershott, op. cit., pp. 55-57

25. Models in De Leeuw, op. cit., De Leeuw and Gramlich, op. cit., and Waelbroeck, op. cit.

26. The long run elasticities were calculated by dividing the coefficients of the explanatory variables by the adjustment coefficient (b) which was calculated from the coefficient of the lag dependent variable of the equation.

27. It should be also mentioned that generally there are reservations concerning both the estimates of elasticities, as they derived mostly from OLS estimation, and their constancy over time. See B. Balassa, "Export Composition and Export Performance in the Industrial Countries, 1953-1971", Review of Economics and Statistics, 61(1979), pp. 604-607; M. Goldstein and M.S. Khan, "The Supply and Demand for Exports: a Simultaneous Approach", Review of Economics and Statistics, 60(1978); P. Newbold, "Discussion of a Paper by D.F. Hendry and J.-F. Richard", International Statistical Review, 51(1983).

10. THE REDUCED FORM OF THE SYSTEM, SIMULATIONS AND FORECASTING

10.1 Introduction

The reduced form and simulation of a model are very important for forecasting and policy purposes. A brief but general description of the problems, the significance and potentialities of these approaches will be given. Assuming that the model under consideration is linear in the variables and the parameters, a simultaneous equation system can be written in the form

10.1.1 $\Gamma Y_t = BX_t + U_t \qquad t = 1.....T$

where Y_t is (G x 1) vector of jointly dependent endogenous variables, X_t is a (k x 1) vector of pre-determined exogenous and lagged endogenous variables. U_t is a (Gx1) vector of disturbances, Γ is a (G x G) matrix of structural parameter of the endogenous variables and B is a (G x k) matrix of structural parameters of the pre-determined variables.

In this structural system each endogenous variable is a linear function of other endogenous and pre-determined variables. To express the jointly dependent variables in terms of the pre-determined ones only, the above system is solved to obtain its reduced form. Assuming then that the matrix Γ is non-singular the reduced form is

10.1.2 $Y_t = \Gamma^{-1} B X_t + \Gamma^{-1} U_t$

or writing $\Pi = \Gamma^{-1} B$ as the matrix of the reduced form parameters and $V_t = \Gamma^{-1} U_t$ the vector of the reduced form disturbances (10.1.2) can be expressed as

10.1.3 $\quad Y_t = \Pi X_t + V_t$

Estimates of the reduced form parameters matrix $\hat{\Pi}$ can be calculated from the relation $\Pi = \hat{\Gamma}^{-1} \hat{B}$, where $\hat{\Gamma}$ and $\hat{B}$ are estimates of the structural form parameters matrices and thus the forecast equation becomes

10.1.4 $\quad Y_t = \hat{\Pi} X_t$

where the error term V_t is set equal to zero, its expected value. The restricted form estimate of the matrix Π from the relation $\Pi = \Gamma^{-1} B$ takes into consideration the over-identifying restrictions imposed on matrix $\hat{\Gamma}$. On the other hand the unrestricted estimate of the reduced form matrix Π is obtained by regressing each Y_t variable on all the predetermined variables in the model. The former method which uses the information of the overidentifying restrictions is asymptotically efficient as compared to the latter but in practice the question often arises about the validity and certainty of the identifying restrictions[1].

Thus using (10.1.4) forecasts for the ℓ period can be obtained as

$$\hat{Y}_{t+\ell} = \hat{\Pi} \hat{X}_{t+\ell} \qquad \ell = 1, 2, \ldots.$$

using actual or projected values for the predetermined variables.

If the matrix of the predetermined variables X_t contains one period lagged endogenous variables together with genuine exogenous variables then the vectors X and the matrix Π of (10.1.3) can be partitioned as

10.1.5 $$Y_t = \Pi_1 Y_{t-1}' + \Pi_2 X_t + V_t$$

In forecasting one period ahead with (10.1.5) the actual value of the lagged dependent variables are used and only the exogenous variables X_t should be projected. Forecasting for more than one period ahead the projected X values and the previously calculated forecasts of the lagged dependent variables are employed.

To study the dynamic properties of a model it is assumed for simplicity that only first order lags of the endogenous variables are included in the set of predetermined variables. Then (10.1.1) can be expressed as

10.1.6 $$\Gamma Y_t = A Y_{t-1} + B X_t + U_t$$

The reduced form of (10.1.6) is

10.1.7 $$Y_t = \Gamma^{-1} A Y_{t-1} + \Gamma^{-1} B X_t + \Gamma^{-1} U_t \qquad \text{or}$$

10.1.8 $Y_t = \Pi_1 Y_{t-1} + \Pi_2 X_t + V_t$

Taking first differences of (10.1.8) the response of an endogenous variable to a unit change in an exogenous variable can be calculated. Hence

$$\Delta Y_t = \Pi_1 \Delta Y_{t-1} + \Pi_2 \Delta X_t + \Delta V_t$$

This response is given by the impact multipliers i.e. the coefficient of Π_2 of the reduced form (10.1.8). By repeated substitution for lagged values of Y_t in (10.1.8) the final form[(2)] of the model (10.1.1) is derived. This expresses the endogenous variables in terms of exogenous (current and lagged) variables only, as

10.1.9 $Y_t = \sum_{j=0}^{\infty} \Pi_1^j \Pi_2 X_{t-j}$

provided that in the limit $\Pi_1^j = 0$ as j tends to infinity.

The model (10.1.1) has an equlibrium if the infinite sum $\sum_{j=0}^{\infty} \Pi_1^j \Pi_2$ of the final form (10.1.9) converges;in this case

10.1.10 $\sum_{j=0}^{\infty} \Pi_1^j \Pi_2 = (I - \Pi_1)^{-1} \Pi_2$

where I is (G x G) identity matrix.

The matrix $(I - \Pi_1)^{-1} \Pi_2$ yields the total or equilibrium multipliers of the system which gives the total effect on the endogenous variables from a unit change in the level of an exogenous variable.

Finally interim multipliers (IM), which give the effect on the endogenous variables of a unit change in the level of an exogenous variable after k periods, can be calculated from the partial sums as

10.1.11 $$IM_k = \sum_{j=0}^{k} \Pi_1^j \, \Pi_2 \qquad j = 0, 1......k$$

In order to take into account the time preference of the changes in the exogenous variables, that is of achieving higher results from these changes earlier in time, discounted multipliers can be also obtained by calculating the average present value of the multiplier series (3). The present value of a multiplier series can be derived as:

10.1.12 $$PVM_k = \frac{1}{k} \sum_{t=1}^{k} \frac{M_t}{(1 + r)^t}$$

where PVM is the present value of the multiplier, M_t the multiplier at time t, r the social rate of time preference, t the number of periods from the beginning of the changes in the variable in question and k the number of periods for which the present value is determined.

The endogenous variables will converge to a stable equilibrium if, as stated above (10.1.9), the matrix Π_1^j tend to zero as j tends to infinity. This will depend on the characteristic roots of the matrix $\Pi_1 = (\Gamma^{-1}A)$. For stability the absolute value of the characteristic roots should be less than one. The model (10.1.1) is a system of difference equations, the solution of which depends on the initial conditions and the values of the exogenous variables. The speed and nature of the adjustment path to equilibrium will depend on the roots of the characteristic equations of the model. Equilibrium will be smoothly approximated if the characteristic roots are real, while an oscillatory path will be followed if the roots are complex.

Generalising, the structural model (10.1.1) with many lags in endogenous and exogenous variables (and assuming that q is the maximum lag) can be written as

10.1.13 $$\Gamma Y_t = A_1 Y_{t-1} + \ldots . + A_q Y_{t-q} + B_o X_t + \ldots + B_s X_{t-s} + U_t$$

where q is the maximum lag in the endogenous variables and s the maximum lag in the exogenous variables.

The reduced form of (10.1.13) then is

10.1.14 $$Y_t = \Gamma^{-1} A_1 Y_{t-1} + \ldots + \Gamma^{-1} A_q Y_{t-q} + \Gamma^{-1} B_o X_t + \ldots + \Gamma^{-1} B_s X_{t-s} + \Gamma^{-1} U_t$$

or

10.1.15 $$Y_t = \Pi_1^* Y_{t-1} + \ldots . + \Pi_q^* Y_{t-q} + \Pi_o X_t + \ldots + \Pi_s X_{t-s} + V_t$$

where Π_i^* (i = 1 .... q) and Π_j (j =0, 1 ... s) are respectively (G x G) and (G x k) matrices of reduced form parameters, and V_t is the reduced form disturbance.

Using the lag operator L, (10.1.13) can be written as

10.1.16 $A(L)Y_t = B(L)X_t + U_t$

where $a(L) = \Gamma - a_1L - \dots - AqL^q$ and

$B(L) = B_o + B_1 L + \dots + B_sL^s$

Pre-multiplying (10.1.16) by A^{-1} we derive the final form as

$$Y_t = a^{-1}(L)B(L)X_t + A^{-1}(L)\ U_t$$

The matrix of interim multipliers is obtained from (10.1.17) $A^{-1}(L)B(L)$ while the matrix of total or equilibrium multipliers may be evaluated from the above expression (10.1.17) by setting L = 1, which gives

$$A^{-1}(1)B(1)$$

On the other hand the system (10.1.13) will be stable if the roots of the characteristic equation of the polynomial A(L) will be outside the unit circle.

In general, interdependent systems like (10.1.1) have a very complicated structure usually with nonlinearities in the variables which will require complex estimation procedures to arrive at the solution of the model.

These difficulties can be significantly reduced if the model is assumed to have a recursive form, in which case causality is determined sequentially. Thus the system[4]

10.1.18 $$Y_t = BX_t + U_t$$

is recursive if

(i) the matrix Γ is triangular,

(ii) the variance - covariance matrix of the current disturbances is uncorrelated and

(iii) current disturbances are also uncorrelated with past disturbances.

In the case of recursive systems OLS can be applied and the estimates derived are consistent.

In practice the above assumptions especially those for the disturbance term, may be difficult to satisfy. The omitted variables represented by the disturbances may exercise an influence on a number of equations in (10.1.18)

These assumptions however may be a better approximation of the relations in the system if it is assumed that the model (10.1.18) is block recursive, a generalisation of the simple recursive form[5].

The equations of a block recursive system can be split into blocks of equations in a way that the equations in each blockare simultaneously determined. But the groups of equations across blocks are recursive, that is the matrix Γ of (10.1.18) is block triangular. Thus assuming that the matrix Γ can be partitioned into n submatrices (10.1.18) will have the form

10.1.19
$$\begin{bmatrix} \Gamma_{11} & 0 \ldots\ldots 0 \\ \Gamma_{21} & \Gamma_{22} \ldots 0 \\ \cdot & \ldots\ldots\ldots \\ \cdot & \ldots\ldots\ldots \\ \cdot & \ldots\ldots\ldots \\ \Gamma_{n1} & \Gamma_{n2} \quad \Gamma_{nn} \end{bmatrix} ; Y = \begin{bmatrix} Y_1 \\ Y_2 \\ \cdot \\ \cdot \\ \cdot \\ Y_n \end{bmatrix} ; U = \begin{bmatrix} u_1 \\ u_2 \\ \cdot \\ \cdot \\ \cdot \\ u_n \end{bmatrix}$$

It is also assumed that the diagonal submatrices Γ_{ii} are square matrices. The block recursive system allows feedbacks within blocks to be taken into account. The estimation of the system (10.1.18) begins with the estimation by consistent methods (e.g. 2SLS) of the variables Y_1 which are simultaneously determined. Then the next block is estimated using the estimates of the current endogenous explanatory variables from the previous block and so on. The required assumption is that the disturbances among the various blocks are mutually correlated.

After the parameters of the equations of the model have been consistently estimated by suitable techniques the structure of the model has been determined. But before the model may be further used for forecasting and policy purposes, it could be useful to examine whether for the estimation sample the models can closely reproduce the economic structure it describes i.e. whether the model can trace the path of the endogenous variables.

Thus the model may be simulated by solving the set of simultaneous equations which constitute it. This is accomplished by using the structure of the model and specifying initial values for the endogenous variables and a time path for the exogenous variables. Then the model is solved over a period of time and solutions for the endogenous variables are produced. Changing the values of the exogenous variables alternative simulation paths of the endogenous variables can be derived.

As the model (10.1.1) is a system of stochastic difference equations, assumptions have to be made about the structural disturbance term before the model is simulated. The usual assumption is that the disturbances U_t are independently and normally distributed with zero mean and a specified covariance matrix.

Thus two alternative simulation procedures can be followed; the structural disturbances are assumed to take the value of their mathematical expectation, that is zeros and then the solution of the endogenous variables are obtained by solving the system. Alternatively stochastic simulation is performed. In the latter case a probability distribution for the error term[(6)] of each equation is specified. Then random normal disturbances with zero mean and a specified covariance matrix are generated and added to the equations which are subsequently solved for the endogenous variables. By repeating the process with new values of random disturbances the distribution of the values of the simulated variables can be traced and studied and thus the dispersion of the stochastic solutions and confidence intervals can be constructed.

To evaluate the results of the simulation of a model, the most commonly applied statistics are the root mean square error (RMSE) and the root mean square percentage error (RMSPE) defined as:

$$10.1.20 \qquad RMSE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s - Y_t^a)^2} \qquad \text{and}$$

$$10.1.21 \qquad RMSPE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\frac{Y_t^s - Y_t^a}{Y_t^a}\right)^2}$$

where Y_t^s is the simulated value of each endogenous variable Y_t, Y_t^a its actual value and T the number of periods in the simulation. A systematic analysis of the RMSE can be provided by Theil's inequality coefficient which is related to RMSE. Theil's inequality coefficients (U) is defined(7) as

$$10.1.22 \qquad U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s - Y_t^a)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^a)^2}}$$

where the numerator of U is the RMSE. By the scaling of the denominator the value of U is between zero (best fit when $Y^s = Y^a$) and one (worst fit).

The numerator of Theil's inequality coefficient can be decomposed as

$$\frac{1}{T}\sum_{t=1}^{T}(Y_t^s - Y_t^a)^2 = (\bar{Y}^s - \bar{Y}^a)^2 + (\sigma_s - \sigma_a)^2 + 2\,(1 - \rho_{sa})\sigma_s\,\sigma_a$$

where $\bar{Y}_s$ $\bar{Y}_a$ σ_s σ_a are the mean, standard deviations of Y^s and Y^a and ρ_{sa} their correlation coefficient. Then the proportion of inequality due to bias (U_M), variance (U_s) and covariance (U_c) can be defined as

10.1.23 $$U_M = \frac{(\bar{Y}^s - \bar{Y}^a)^2}{\frac{1}{T} \Sigma \, (Y_t^s - Y_t^a)^2}$$

10.1.24 $$U_s = \frac{(\sigma_s - \sigma_a)^2}{\frac{1}{T} \Sigma \, (Y_t^s - Y_t^a)^2}$$ and

10.1.25 $$U_c = \frac{2(1 - \rho_{sa}) \sigma_s \sigma_a}{\frac{1}{T} \Sigma \, (Y_t^s - Y_t^a)^2}$$

The sum of these proportions equals 1 ($U_M + U_s + U_c = 1$) and they show the sources of the simulation error.

The first source of error (U_M) is caused by the difference in the means of Y^s and Y^a and indicates the existence of a systematic bias in the model. The variance component (U_s) accounts for the error due to difference in the variances of Y^s and Y^a. Finally the third source of error (U_c), the error due to difference in their covariances, explains the unsystematic error which remains after the errors originating from systematic factors and the variabilities have been taken into account.

Another important test for the evaluation of simulations is whether the model simulates the turning points of the actual values, that is sudden changes in the historical values of the variables.

After the model has been tested it can be used for forecasting and policy analysis.

Forecasts can be distinguished in unconditional and conditional ones. In the former case the values of the explanatory variables are known with certainty for the whole forecasting period, while in the latter at least some of the explanatory variables have to be predicted for the future before the model can be used for forecasting purposes.

The aim is to derive the best possible predictions, those with a small forecasting error. Forecasting errors are due to multiple factors, such as the random nature of the disturbance term in the equations, specification errors in the model, errors due to the forecasts of the exogenous variables, and errors caused by the parameters estimates which though unbiased may not be identical to the true parameter values.

A criterion for the best forecasts is that it yields a forecasting error with minimum variance. In the case of unconditional forecasts from a simple model of the form

$$Y_t = a + bX_t + u_t \qquad \text{and } u_t \sim N\ (0,\ \sigma^2)$$

the forecasting error one period ahead u_{t+1} $(= \hat{Y}_{t+1} - Y_{t+1})$ is normally distributed, as a linear function of normally distributed parameters, with zero mean that is the forecast $\hat{Y}_{t+1}$ will be unbiased.

The variance of the forecast error is given[8] by

$$10.1.26 \qquad \sigma_F^2 = E\,[(u_{t+1})^2] = \sigma^2\,[1 + \frac{1}{T}\frac{(X_{t+1}-\bar{X})^2}{\sum_{t=1}^{T}(X_t-\bar{X})^2}]$$

where T is the number of observations in the sample. Conditional forecasts on the other hand, involve the calculation of future values for the variable X_t, which are stochastic in nature and thus the forecast error of the endogenous variable Y_t will be larger than the unconditional one, as it is also a positive function of the forecast error of the exogenous variables.

10.2 The Reduced Form of the Model

The reduced form of the model is estimated from the first stage OLS regression of the 2SLS estimation process, that is the unrestricted reduced form estimates were used.

As it was mentioned above (Section 10.1) the unrestricted reduced form parameter estimates produce forecasts that are asymptotically inefficient compared with those derived from the restricted reduced form estimates which take into account the over identifying restrictions imposed on the structural form. But in practice the validity of the restrictions imposed on the structural form are not certain and have to be tested. In the present study as the whole model is used for forecasting and simulation purposes the proper procedure would be to test the restrictions on the model as a whole. In this case the likelihood ratio test would be required but it was precluded because it would involve the estimation not only of the OLS estimates of the unrestricted reduced form parameters but also the full information maximum likelihood (FIML) or 3SLS estimates of the structural form parameter matrices and the covariance matrix, which methods were not attempted. On the other hand testing the overidentifying restrictions in a limited information framework, that is on the basis of a single equation in the system, would require the application of an F form statistic.

When the equations are estimated by 2SLS that is when they have the form

$$y_i = Y_i \gamma + X_i b + u_i$$ The F statistic is

$$\frac{T - K}{K - m_i} \; \frac{(y_i - Y_i\hat{\gamma})' \; (M_i - M) \; (y_i - Y_i\hat{\gamma})}{(y_i - Y_i\hat{\gamma})' \; M \; (y_i - Y_i\hat{\gamma})}$$

where T is the number of observations, k the number of the exogenous variables in the whole model, m_i is the number of exogenous and explanatory endogenous variables included in the estimated equation, $M_i = I - X_i (X_i' X_i)^{-1} X_i'$ and $M = I - X (X'X)^{-1} X'$ (X is the matrix of the predetermined variables in the whole model).

A high value of this statistic would imply that the imposed restrictions are not valid and some of the excluded predetermined variables should have been included in the equation. The result of this process would be of rather a limited importance because even if the test were satisfied this could not be taken as an indication that the model as a whole forms a reasonable system(9).

Taking into consideration these problems it was decided to use the unrestricted reduced form estimates rather than compute the restricted ones although this would result, as stated above, in a loss of efficiency.

The estimation of the unrestricted reduced form parameters was obtained from the first stage of the 2SLS estimates, that is by regressing the endogenous variables on all the predetermined variables in the whole model (lagged endogenous, exogenous and lagged exogenous).

As in the present study the number of predetermined variables exceeds the number of observations in the sample, the first stage regression was not possible. Two of the methods advanced for the solution of this problem are

(a) the structurally ordered instrumental variables (SOIV) proposed by Fisher [10]. By detailed study of the structure of the model a limited number of predetermined variables are selected to be used in the first stage, and

(b) the two stage principal components estimator (2TSPC) proposed by Kloek and Mennes [11]. This uses a limited number of principal components of the predetermined variables in the first stage estimation.

The basis of the SOIV method is the extensive use of the information contained in the structure of the model in the form of the normalization of the variables and a priori restrictions imposed on the equations. Thus a set of instruments for each endogenous variable can be selected[12].

The dependent variable in each behavioural equation in the model is explained by other endogenous variables and a number of predetermined variables. For each of the right hand side endogenous variable a preference ordering of instruments is constructed as follows. The predetermined variables in the right hand side of the equation under investigation are termed of first causal order. Considering then the equations which explain the other endogenous variables in the right hand side of this equation another set of predetermined variables is obtained, termed of second causal order. Continuing this process until no more right hand side endogenous variables are encountered, a list of predetermined variables is constructed, ranked according to their causal order numbers. Thus the predetermined variables of first causal order explain the endogenous variable directly- the second causal order predetermined variables explain other variables which directly affect the given endogenous variable and so on. This list of instruments is further reduced to avoid the effects of multi collinearity using the information from the sample correlations. Thus the variables to be used in the first stage regression are finally selected.

The SOIV method is sophisticated but computationally expensive as it uses all the information available in the structure of the model to select the suitable number of instruments, which may be different, for each endogenous variable in the same equation. The full potential of the method can be achieved in models which are sufficiently block recursive. As research in considerably interdependent systems has shown the relatively simpler and less computationally expensive method of two stage principal components approach performs equally well and may be preferred[13].

Because of the complexities and the conditions necessary for the efficient use of SOIV, the second method of two stage principal components (2TSPC) was employed in this study to construct the regressors used in the first stage. In this method the principal components associated with the largest characteristic roots of the correlation matrix of the standardised predetermined variables in the whole model are used as regressors in the first stage. To ensure consistency, the predetermined variables of the equation to be estimated should also be included separately in the first stage regression[14]. The number of components employed in the first stage is determined empirically and as it has been suggested if they account for 95% of the variation of the predetermined variables the method will produce reliable and stable estimates of the parameters[15]. Kloek and Mennes who proposed this method have suggested some modifications to 2TSPC in order to reduce the number of regressors in the first stage and also mitigate the effects of multicollinearity. They finally suggested that principal components have to be calculated in all the predetermined variables in the model, and the components that explain the least variance of the predetermined variables of each equation (X_i) should be employed in the first stage. But research has tentatively indicated that this elaborate version has resulted in unsatisfactory estimates compared to the straightforward 2TSPC method described above[16].

Taking into consideration all these factors the method of two stage principal component (2TSPC) was used for the estimation of the structural equations of the model in addition to those of OLS and GLS (first order autocorrelation process).

The principal components were calculated on all the lagged endogenous, some of the exogenous, and the lagged exogenous variables in the model. The exogenous variables withheld from the principal components analysis were: the current expenditure of government on goods and services at constant 1970 prices (GCE), government net transfers to households at constant 1970 prices (GTHN), the exchange rate (ER) and the discount rate (DIRA). These were included separately in the reduced form regressions in order to study directly their impact on the endogenous variables. The dummy variable (D74) for the increase in the price of oil in 1974 was also included separately to observe its effect on the dependent variables(17).

Using the principal components technique on all, but the above mentioned, predetermined variables reduces the number of variables employed in the reduced form regressions, so that they can be estimated, and at the same time diminish the effects of multicollinearity(18). The new created variables (components) are linear combinations of the original ones, uncorrelated with each other and accounting for the maximum of the variance of the original variables. On the other hand the resulting components are linear combinations of many and usually dissimilar variables. To mitigate the importance of the dissimilarity existing among several variables a second modification was introduced in the calculation of principal components.

The predetermined variables, on which factors were calculated, were split into two broad sets(19). In the first set the variables which accounted for the real and nominal magnitudes in the model were included, while the second set contained price indices, relative prices, the rate of indirect taxes and interest rates. For each of these two sets of variables factors were calculated which were subsequently used in the estimation of the reduced form.

Another reason which prompted the split of the predetermined variables into two sets, was the small size of the sample. The calculation of principal components on all the predetermined variables together, taken as one set, could result in components which could be identified with particular subjects of variables which are regarded as exercising an important influence on the endogenous variables as for example prices or interest rates. But to achieve that it might require the inclusion of a large number of components, relative to the sample size, so that a meaningful estimation of the reduced form equations could not be possible. (That is, the purpose was to economize on the degrees of freedom and for the components to be easily identified.)

Thus to derive the unrestricted reduced form parameters the endogenous variables were regressed by OLS on GCE, GTHN, ER, DIRA, D74 a constant term and on a number of factors from each of the above mentioned two sets.

The number of the retained factors, extracted from the correlation matrix after standardising the variables included in each set, was determined mainly on the amount of the total variance in the original variables they accounted for, and on the magnitude of their corresponding characteristic roots. That is components were retained as long as they accounted for at least 95% of the total variance and the associated with them characteristic roots exceeded one in magnitude[20].

It should be parentetically mentioned here that in the first stage regressions of the 2SLS (with principal components) estimation of the structural equations not only the above mentioned variables (exogenous and factors) were used as regressors, but in addition the predetermined variables included in the estimated equation so that consistency of the structural parameters could be ensured[21].

The calculated factors[22] from each set were then rotated so that a simpler pattern and a meaningful interpretation could be attached to each of them. Because of the high degree of interelatedness existing among the various economic magnitudes it was considered useful to perform not only orthogonal but oblique rotation as well on the retained factors.

On the other hand to explore the above mentioned advantages of estimating recursive systems, an attempt was made to estimate the model in a block recursive form. By examining the structure of the model, that is the inclusion of current endogenous variables in each equation of the system, three blocks could be identified, assuming that the disturbances between blocks are uncorrelated, that is the variance-covariance matrix is block diagonal.

The first block contains the wage[23] and price equations in which no current endogenous variables from the other two blocks are involved. The second block consists of the financial equations of the model in which current endogenous variables of the first block (wage-prices) are included. Finally the third block, which contains the remaining equations of the model, determines the components of the final expenditure, employment, taxes, unemployment, the transactions with other countries and is influenced by the endogenous variables in the other two blocks.

Thus several models were tried to derive the estimates of the unrestricted reduced form equations of the endogenous variables.

The selection among the various reduced form models, was decided to be based on how well each of them would be tracking down the original data. The criterion to be employed was the root mean square percentage error (RMSPE) calculated for some important variables of the model. The reduced form model with the minimum RMSPE for these variables would be selected.

Thus by determining the initial conditions and the time path of the exogenous variables, a historical dynamic simulation was performed for each one of the various reduced form models, using for the lagged endogenous variables the values generated by the equations of the models. The RMSPE was then calculated on the deviations between the simulated and the actual values of the endogenous variables[24].

It was also decided to take into consideration, in selecting the best model, the RMSPE of the forecasts generated dynamically by the various reduced form models, extending the period of calculating the RMSPE by taking into consideration the years outside the sample period for which data exist[(25)], and for which the forecasts were calculated.

The finally selected model was also used for the first stage regression of the 2SLS with principal components estimation of the structural equations.

10.3 The Results of Factor (Components) Analysis

As it has already been mentioned the predetermined variables of the simultaneous system were split into two separate sets and principal components were calculated for each set. For the block recursive system the factors were similarly calculated for each of the two separate sets of variables which were included in any particular block[(26)].

The components were calculated by using the SPSS program which utilizes Harman's approach[(27)].

For the first block of the recursive model the eigenvalues and the factor loadings are presented in the Tables 1 and 2 in Appendix 2. These tables indicate that only the first eigenvalue exceeds one but two factors are needed so that the percentage of variance accounted for by them would be at least 95 per cent (the figure from the tables shows that the cumulative percentage of variance for two factors is 96.2 per cent). The factor loadings (Table 2) reveal that the four variables included in the pricnipal components analysis are clustered into the first two factors. The first factor captures the trend of the variables (the unemployment variable's loading is negative) while on the second factor the only variable with a loading of considerable magnitude is unemployment. It should be also mentioned that nominal housing investment has a sizeable loading (0.314) on the third factor as well. The principal components results for the logarithms of these variables show the same pattern. The first two components account for 99.5 percent of the variance, while only the eigenvalue associated with the first factor exceeds one, its magnitude being 3.688 (Table 3 Appendix 2). The variables are clustered entirely in the first two factors and none of them has a loading of considerable magnitude on the rest two factors (Table 4 Appendix 2).

The clustering of these variables (in their original or logarithmic form) into two factors appeared more clearly when the factors were rotated orthogonally and this pattern was reinforced when oblique rotation, which allows the factors to be correlated was applied (Tables 21 and 22 Appendix 2).

Two factors accounted for over 99 per cent of the total variance of the variables (implicit deflators and the rate of indirect taxes) of the second set which were included in the first block, whether their actual values or their logarithms were subjected to principal components analysis. (Tables 5 and 7 Appendix 2.)

There was a clear grouping of the variables on the first two factors, while the factor loadings on the remaining factors were quite small as it can be seen for the third and fourth factors included in the Tables 6 and 8 in Appendix 2. On the first factor the implicit deflators are clustered, while the rate of indirect taxes (RIT) loads heavily on the second factor. The rotation, whether orthogonal or oblique, substantiated this pattern of grouping of the variables (Tables 6 and 8 Tables 23 and 24, Appendix 2).

For the second block of the recursive system two factors account for 95.4% of the variance of the variables in the first set, while only the eigenvalue associated with the first factor exceeds one (its magnitude being 7.066). For the second set of variables the magnitude of the eigenvalues associated with each of the first two factors exceeds one, while the cumulative percentage of the variance of the variables accounted for by them is 97.2 (Tables 9 and 11 Appendix 2).

All the variables included in the first set have very high loadings on the first factor which appears to capture the trend. At the same time, the productivity variable, the time trend and the unemployment have also fairly large loadings exceeding 0.30, on the second component, while unemployment has a sizeable loading on the third factor as well, although its magnitude is slightly smaller than on the second (0.396 on the second factor and 0.375 on the third) as Table 10 shows (Appendix 2).

For the second set of variables, the deflators have very large loadings on the first factor, while the two interest rates variables (on deposits RD, and on long term credits, RL) are clustered mainly on the second factor, although interest rate on deposits has a large loading of 0.61 on the first factor as well. The rate of indirect taxes has loadings of almost equal size of 0.351 and 0.361 on the first and third factors respectively, while it also has a negative but large loading of -0.862 on the second factor.

The remaining factors for both sets of variables have fairly small loadings as the fourth factor demonstrates in Tables 10 and 12 (Appendix 2).

As it was mentioned above, unemployment has a loading on the third factor (first set of variables) of almost equal magnitude to that of the second factor, and for the second set of variables, the rate of indirect taxes loads almost equally on the first and third factors. Consequently it was decided to retain only two factors for each set of variables (which account for more than 95 per cent of the total variance), although the results, previously analysed, have indicated that a third factor for each set of variables might also have been retained and tentatively tried in the reduced form regressions.

The orghogonal rotation of the two factors (first set of variables) led to the clustering on the first factor of the variables expressed in nominal terms, while productivity and the time trend clustered on the second factor. In the oblique rotation the pattern was not so clear although a sequence of values (ranging from -1 to 1 in steps of 0.1) was tried for the parameter δ, which controls the oblique rotation. On the finally chosen oblique factors, the variables expressed in value terms, are again heavily loading on the first one (with small loadings on the second) while the remaining three variables have large loadings on both of them (Table 25 Appendix 2).

For the second set, the included variables are clearly clustered on the two factors, in both the orthogonal and the oblique rotation. On the first factor the various deflators have very large loadings and on the second the two interest rates variables are grouped together. The rate of indirect taxes has large, and of opposite sign, loadings on both components (Table 26 Appendix 2).

The third block of the recursive system and the simultaneous system include the same predetermined variables.

For the first set of variables only the eigenvalues associated with the first two components exceed one, while the cumulative percentage of the total variance they account for is 95.9 per cent, while 98.8 per cent is accounted for by the first four factors. Almost the same picture emerged for the logarithms of these variables. The cumulative percentage of the variance accounted by the first two factors (with eigenvalues in excess of one) is 94.3 while four factors account for 98.5 per cent of the total variance (Tables 13 and 15 in Appendix 2).

Table 14 (Appendix 2) reveals that all the 26 variables of the first set load heavily on the first factor, the magnitude of the loadings exceeding 0.85. This factor captures the trend of the variables, and all of them have positive loadings except the unemployment which is negatively related to them. Some of the variables have positive or negative loadings of considerable magnitude on the second factor as well but without a clear pattern. The variables which have fairly large positive loadings on this factor are those expressed in nominal terms and the imports of oil (M3) the latter expressed however in real terms. On the third factor inventory investment (II) has a negative loading of

-0.424 while unemployment loads on both the third and the fourth factors with loadings of 0.251 and 0.422 respectively. No loadings of considerable magnitude or a concentration of variables which could give an interpretable pattern, appears on the rest of the remaining factors as the fifth of them for example shows in Table 14 (Appendix 2).

The same pattern emerges for the factors of the logarithms of the variables (Table 16 Appendix 2). The main difference is that deposits (DEP), loans (LOAN), and money (CUR), which are expressed in first differences, have large loadings, of almost similar magnitude, on both the first two components. It should be also noted that some of the investment variables have sizeable loadings on the third factor as well.

When the factors were orthogonally rotated a clearer pattern of the way the variables were concentrated on the four factors (with sizeable loadings) emerged. On the first factor the variables expressed in nominal terms were clustered, while on the second factor the variables in real terms were mainly grouped together. The foremost exception is the imports of oil (M3) expressed in real terms, which clusters together with the variables in nominal terms, (its loading on the first factor, after rotation, is 0.815, while on the second is only 0.363). This reflects the importance of oil for the economy, as it is a basic material especially needed for the production of energy, and demonstrates that the quantity of oil demanded is inelastic and relatively weakly influenced by the price movements. A similar, but weaker, pattern is followed by the exports of goods (XG) and the consumption of durables (CD). These variables, as their loadings reveal (Table 27, Appendix 2), trace the pattern of the nominal variables and indicates that their demand is relatively less sensitive to price movements in the period under consideration and that, in the case of exports of goods, the export price continues to be competitive.

On the third factor the prevailing variable is inventory investment with a loading of 0.583 while unemployment (UN) is the dominant variable on the fourth factor (loading -0.613) as Table 27 shows (Appendix 2).

In the oblique rotation there were difficulties in establishing an interpretable pattern of factors at low values of correlation between them (that is for low values, between -0.9 and 0.3 of the parameter δ which controls the oblique rotation[(28)]). Very few variables have loadings of some size (around 0.20) on the first couple of factors, while in the remaining factors the variables clustering together were quite dissimilar, so that a clear interpretation could not be attached to them. Finally by successive oblique rotations (increasing the value of δ by steps of 0.1) a pattern of grouping of the variables to the retained factors with a meaningful interpretation emerged. This cluster coincided with that of the orthogonal rotation as Table 28 (Appendix 2) reveals, but, in contrast to the orthogonal rotation, the variables in real terms are concentrated on the first component. The value of the parameter δ was 0.5, indicating that strong correlation exists between the factors, the values of the factor pattern correlations ranging between 0.81 and 0.97.

On the other hand, the rotation, whether orthogonal or oblique, of the factors derived from the logarithms of these variables, did not succeed in producing factors with a structure equally simple and clear to interpret, as that of the factors derived from the actual values of the variables. In the orthogonal rotation, the variables in real terms are concentrated on the first factor. But some of the variables in nominal terms have large loadings on both the first two factors, while those nominal variables in first differences (ΔLO and ΔCUR) are grouped on the third factor.

In the oblique rotation these variables in first differences are loading instead on the second factor, while the first factor accounts for the trend of the remaining variables in real and nominal terms. On the third factor the investment and the financial variables (ΔDEP, ΔLO, ΔCUR) have quite sizeable loadings. In both types of rotation, on the other hand, the fourth factor is dominated by the unemployment variable.

For the second set of variables, included in the third block of the recursive and in the simultaneous systems[(29)] the eigenvalues associated with the first two factors exceeded one, while the cumulative percentage of the total variance of the variables accounted for by them just exceeds 90 per cent. When four factors are employed the cumulative percentage of variance accounted for, rises to over 98 per cent (Table 17, Appendix 2).

As Table 18 (Appendix 2) shows the various deflators are clustered on the first factor while the second is dominated by the two interest rates variables (RD, RL), the rate of indirect taxes (which has a negative loading) and the relative price variable (PG/PT_1) which is the ratio of Greece's consumer price index over a weighted average of consumer price indices of six countries from which most of the tourists come from. The last two variables have sizeable loadings on the fourth factor as well, while on the third factor the relative price variable (PC/PT_2) of the tourism services of four competing countries heavily loads.

The same pattern of results appears in Tables 19 and 20 (Appendix 2) derived from the logarithms of the variables in the second set.

The orthogonal and the oblique rotations reproduced the same pattern of clustering of the variables on the four components without significant differences from those already mentioned as the Tables 31, 32, 33 and 34 (the last two tables for the logarithms of the variables) in Appendix 2 show.

The only difference of some importance is that in the oblique rotation the rate of indirect taxes (RIT) has a large loading on the fourth factor, while in the orthogonal rotation the variable PG/PT_1 has a large loading on it (Tables 31 and 32 Appendix 2).

For the logarithms of the variables in the oblique rotation, both RIT and PG/PT_1 have large loadings on the fourth factor (Tables 33 and 34 Appendix 2).

To arrive at factors with a meaningful interpretation in the case of oblique rotation, the value of δ is chosen at the level of 0.5 which indicates that the factors are considerably correlated, with the values of factor pattern correlations ranging between 0.55 and 0.90[30].

Thus, for the first block of the recursive system two factors were retained from each of the orthogonal and oblique rotation, whether factor analysis was applied on the actual or the logarithmic values of the variables. The first component is identified with the trend of the real and nominal variables included, while the second is associated with unemployment, which is negatively related to the other variables loading on this component. For the second set of variables two factors were also retained from each type of rotation. The first factor is associated with thevarious deflators involved in this set while the second factor is identified with the rate of indirect taxes. To the factors calculated from the logarithms of the variables the same interpretation can be attached.

Two factors were also retained from each type of rotation of each set of variables belonging to the second block of the recursive system. But the pattern of clustering of the variables has changed. On the first factor (for the first set of variables) the variables expressed in nominal terms are concentrated while the second factor can be identified with the variables in real terms and with unemployment (in oblique rotation (Table 25, Appendix 2) the interpretation of the factors is not so clear as real variables have large loadings on the first factor as well). For the second set of variables, the first factor is again identified with the various deflators involved, while the second is mainly associated with the interest rates variables, although the rate of indirect taxes has a large but negative loading on this factor.

For the third block of the recursive and for the simultaneous systems, four components were retained from each type of rotation of each set of variables whether their actual or logarithmic values were subjected to factor analysis. For the first set of variables the first component is identified with the variables in nominal terms, while the second is associated with the variables in real terms (in the oblique rotation this pattern is reversed. Tables 27 and 28, Appendix 2). The third factor has not a very clear pattern but it can be related to inventory investment (II) which also has sizeable loadings on the first two factors.

The fourth factor is dominated by the unemployment variable. (This pattern of interpretation though not so clear generally also holds for the factors derived from the logarithms of the variables as mentioned in detail above.)

For the second set of variables, as the analysis before has shown, the first factor is identified with the various deflators, and the second mainly with the interest rates variables. The third factor can be associated with the relative price variable PC/PT_2. On the fourth factor no specific interpretation can be associated, as the variables with large loadings on it, change either with the type of rotation or if the logarithms of the variables are used. Thus, either the relative price PG/PT_1, or the rate of indirect taxes or both of them have large loadings on the fourth factor.

But keeping eight components for the third block and the simultaneous system (four factors from each set of variables) would aggravate the problem of degrees of freedom arising from the small size of the sample, thus making questionable a meaningful estimation of the reduced form parameters. On the other hand on the third and fourth factors of each set of variables, there are only one or two with relatively large loadings.

Consequently it was decided to include in the reduced form equations only four factors (the first two from each of the two sets of variables) and dropping the remaining ones.

But as this decision could have important effects on the reduced form estimates, it was also decided, as a compromise solution to this problem, to calculate two estimates for each one of the retained two factors (from each set of variables) which were included in the reduced form equations.

The first estimate was estimated from the matrix of factor loadings when two factors were kept. The second estimate on the other hand, was also calculated from the matrix of factor loadings, but in this case, four factors were involved.

Hence, as previously mentioned, to estimate the reduced form equations, each endogenous variable was regressed on four exogenous variables (government current expenditure on goods and services in real terms (GCE), government net transfers to households in real terms (GTHN), the discount rate (DIRA), and the exchange rate (ER) variable), the constant terms, the dummy variable (D74) and on four factors (two from each set of the remaining predetermined variables in the model), which are mainly associated with the variables expressed in real terms, the variables expressed in nominal terms, the various deflators and the interest rates variables.

Consequently the following six sets of reduced form equations were estimated:

(i) The three block recursive system with orthogonal factors,

(ii) The three block recursive system with oblique factors,

(iii) The simultaneous system with orthogonal factors (calculated from the matrix of factor loadings with four factors involved),

(iv) The simultaneous system with orthogonal factors (calculated from the matrix of factor loadings with two factors involved),

(v) The simultaneous system with oblique factors (calculated from the matrix of factor loadings with four factors involved), and

(vi) The simultaneous system with oblique factors (calculated from the matrix of factor loadings with two factors involved).

The predetermined variables (in the two sets of variables) for which factors were derived, were standardised and then multiplied by the factor score coefficients[(31)] to calculate the components vectors which were subsequently employed in the estimation of the above set of reduced form equations.

10.4 Simulations and Forecasts

In preliminary estimations of the reduced form equations the value of the Durbin-Watson statistic indicated that almost all of them were suspect of autocorrelation (the magnitude of this statistic was very low, lying either in the region of positive autocorrelation, or in the inconclusive region). Because of the consequences of autocorrelation, it was decided to re-estimate all the reduced form equations (in the above six sets) with a first order autocorrelation process. The Hildreth-Lu procedure[32] was used by specifying a grid of values for ρ , the autocorrelation coefficient, in the interval (-1 to 1 by steps of 0.05) and the equation with the lowest sum of squared residuals was selected as the reduced form for each endogenous variable.

As it has already been mentioned, it was decided to base the comparison of the above six reduced form models on the criterion of the root mean square percentage simulation error (RMSPE) and to select as the best model the one with the minimum RMSPE on a number of important variables for the economy. These variables were: GNP and market prices and at factor cost (they were calculated from the identities of the system[33]) and its components (for example total consumption, total investment), the two basic prices in the system (the consumer price index, and the implicit deflator of GNP at market prices) and unemployment.

Instead of calculating the RMSPE on the deviations between the one-period ahead forecasts and the actual values of the variables, it was decided to base these calculations, and hence the selection of the best model for the reduced form equations, on the dynamic forecasts generated by each model, which is considered as stringent test of the ability of a model to track closely the actual data[34].

That is, given the actual values of the lagged dependent variables for the initial period and the time path of the exogenous variables over the simulation period, the model generates each period the values of the endogenous variables, which are then used as inputs for the next period's lagged dependent variables, thus generating the series of the values of the endogenous variables over the specified number of periods.

As for the period 1954-1956 data for unemployment do not exist or are considered unreliable and as in 1959 a new consumer price index was introduced, it was decided to choose as the initial conditions of the simulations, the values of the variables in the previous year 1958.

The simulations performed were not stochastic. It was assumed that the disturbance terms (U_t) of the structural equations were zero, that is they were replaced by their mathematical expectations[35].

The four factors included in the right hand side of the reduced form equations were also re-calculated each period by using the generated, by the model, values of the lagged dependent variables.

Thus for each of the six sets of the estimated reduced form equations historical simulations were performed for the period 1959-1977 and the RMSPE for the variables mentioned above were calculated and compared.

As Table 1 in Appendix 3 reveals, when the oblique factors are used, the simultaneous system performs better than the block recursive. For all the variables[36] the RMSPE is smaller from the simultaneous system estimates than from those of the recursive. When the orthogonal factors are employed the simultaneous system still performs better than the recursive, even though a few variables of the latter system have slightly smaller RMSPE (e.g. GNPM, TC).

But what should be stressed is that the simultaneous systems (whether orthogonal or oblique factors were employed) perform much better than the recursive ones with respect to the variables included in the first and the second block of the recursive systems and for which (blocks) a smaller number of predetermined variables was employed in their estimation[37].

As Table 1 (Appendix 3) demonstrates the RMSPE for CPI and PGNPM is almost doubled compared with the corresponding figures from the simultaneous systems (CPI from 5.29 to 9.50 with orthogonal factors and from 4.99 to 11.23 with oblique factors; for PGNPM the corresponding figures are: from 5.13 to 9.44 and from 5.17 to 10.84).

The weakness of the recursive models to track closely the values of the price variables, relative to simultaneous systems, is further indicated by the comparison of the figures of the RMSPE for total exports and imports when their nominal and real values are used, as the table below shows: (part of Table 1 Appendix 3).

RMSPE for Exports and Imports of Goods and Services in Real and Nominal Terms 1959-1977

	ORTHOGONAL FACTORS		OBLIQUE FACTORS	
	Simultaneous System	Recursive System	Simultaneous System	Recursive System
X	11.07	10.59	9.10	10.10
XV	14.31	19.48	11.19	17.02
M	8.40	9.66	9.98	10.55
MV	11.52	19.00	12.84	21.99

(X = real total exports; M = real total imports; XV = nominal exports; MV = nominal imports.)

The simultaneous systems also track better the values of the interest rate of long term credits to industry (RL) which is included in the second block of the recursive systems. It should be also pointed out that both the simultaneous and the recursive systems (especially the latter) fail to track the figures for unemployment as the large magnitude of the RMSPE demonstrate (Table 1, Appendix 3).

Finally, for the sets of reduced form equations, for which the factors were estimated from the matrix of factor loadings with two retained factors, the RMSPE are shown in Table 3 (Appendix 3).

These results compared with those of the corresponding simultaneous systems of Table 1 (Appendix 3) reveal that when the factors are calculated in this way (from a matrix of factor loadings with two retained factors) the system is entirely inadequate to trace the actual data. The RMSPE have been three and sometimes four times larger than the corresponding magnitudes shown in Table 1 (Appendix 3).

The simulated values of most of the variables shown in the Table 3 (Appendix 3) follow a similar cyclical path. At first, from 1962 to 1967 they overestimate the original observations. reaching a peak at 1965. From 1967 to 1974 the original observations are underestimated by the simulated values (the lowest level reached in 1971). Then the simulated values follow the path of the original values but continuously diverging from them especially near the end of the sample period.

Thus these results suggest that more than two factors are needed to be retained (in the matrix of factor loadings), so that to produce estimates which could track the data fairly satisfactorily.

These comparisons also indicate that more than four factors could have been retained and included in the estimated reduced form equations to investigate their performance in simulation and forecasting exercises. But this attempt would require the estimation of new and more systems, involving large numbers of equations, and was thus precluded, time limitations also taken into consideration.

For both the simultaneous systems the magnitudes of the RMSPE for most of the variables are very similar (Table 1, Appendix 3). Thus it was decided to use both these systems to generate forecasts outside the sample period from 1978 to 1982, for which period values for almost all the exogenous variables were available.

10.5 Prediction of the Exogenous Variables

The three exogenous variables for which figures were not available are: the government's transfers to households net (GTHN), and the composite variables of the relative price of tourism services of Greece and its competitors (PG/PT1) and (PC/PT2). To construct these composite variables the consumer price indices of the countries involved and the number of tourists were needed[38]. However, data for GTHN were available only up to 1979 and for the number of tourists up to 1980.

Thus the values of these exogenous variables had to be predicted for the missing years and consequently the forecasts generated by the two simultaneous systems for these years were conditional upon the predictions of these exogenous variables.

At first the Box-Jenkins methodology for time series models was employed, and the basic properties of ARIMA models, a broad class of time series models is given briefly below[39].

Time series can be assumed as generated by a stochastic process which can be characterised by a probability distribution. If furthermore the process has a joint normal distribution, it can be described by its means variances and covariances. But because of the large number of these parameters the need for simplifying assumptions arises. Such an assumption is stationarity, implying that the stochastic process is invariant with respect to time, and its probability distribution is independent of time.

For analysing time series models the autocovariance and autocorrelation functions are useful. Assuming a time series Y_t ($t = 1, 2, \ldots, T$) the covariance between the values Y_t and Y_{t+k}, the autocovariance at lag k, is defined as

10.5.1 $\gamma_k = \text{COV}(Y_t, Y_{t+k}) = E(Y_t - \mu)(Y_{t+k} - \mu)$ where μ is the population mean, and the autocorrelation function is

10.5.2 $$\rho_k = \frac{E(Y_t - \mu)(Y_{t+k} - \mu)}{\sigma_y^2} = \frac{\gamma_k}{\gamma_o}$$ where $\sigma_y^2 = \gamma_o$ as the process is stationary.

To analyse time series it is necessary to specify models that allow the time series to be characterised by a small number of parameters. One general class of these models is the autoregressive moving average model (ARMA). In this model the current value of a time series Y_t, depends on its past values (the autoregressive part) and the current and past values of a random error term, a_t (the moving average part). The ARMA model has finite autoregressive and moving average parts of order p and q. Thus an ARMA (p,q) model can be written as

10.5.3 $$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots - \theta_q a_{t-q}$$

or using the lag operator (L) as

10.5.4 $$(1 - \phi_1 L - \phi_2 L^2 - \cdots - \phi_p L^p) Y_t = (1 - \theta_1 L - \theta_2 L^2 - \cdots - \theta_q L^q) a_t$$ or

10.5.5 $$\phi(L) Y_t = \theta(L) a_t$$

For q = 0 the autoregressive model of order p, AR(p), and for p = 0 the moving average model of order q, MA(q), are respectively derived.

The autoregressive process can be expressed as a weighted sum of current and past error terms a_t. If it is also assumed that the probability distribution of the process is normal the stationarity assumption requires that the variance of the process to be finite, and this can be realised if the roots of the characteristic equation of the polynomial $\phi(L) = 0$ lie outside the unit circle. Another important property is that of invertibility, which implies that a moving average process can be represented in terms of the past values of Y_t, that is it can be represented as an autoregressive process. In order for the condition of invertibility to be realised the coefficients of past terms in Y_t should converge and this could be achieved if the roots of the characteristic equation of $\theta(L) = 0$ lie outside the unit circle. It should be noted that the stationarity property of a process is independent of the invertibility condition. Thus an ARMA process could be stationary without the invertibility condition being satisfied and vice versa.

As it was mentioned above when a process is stationary its probability distribution is independent of time, that is the mean and variance are constant while the autocovariances depend only on the time lag. However many observed time series are not stationary and their level and/or their variance change, with time. When the observations are influenced by trends while, apart from these trends, one part of the series behaves like the others, the process is called homogeneous nonstationary.

A homogeneous nonstationary time series can be transformed into a stationary one by suitable differencing. Thus the time series Y_t is homogeneous nonstationary of order d if

10.5.6 $\quad W_t = \nabla^d Y_t$

is stationary where ∇ is the difference operator, that is $\nabla Y_t = Y_t - Y_{t-1} = (1-L)Y_t$. This model is called autoregressive integrated moving average process (ARIMA) of order (p, d, q). As the new series W_t is stationary it can be expressed as an ARMA (p,q) process, thus

10.5.7 $\quad \phi(L)W_t = \theta(L)a_t \quad$ or

10.5.8 $\quad \phi(L)(1-L)^d Y_t = \theta(L)a_t$

In the model above (10.5.8) p-d of the roots of the characteristic equation of $\phi(L) = 0$ are outside the unit circle and d roots are on the unit circle.

After the process has been transformed by differencing into an ARMA (p,q) process the autocovariance and autocorrelation (ACF) functions can be used to analyse it. But a large proportion of the correlation between Y_t and Y_{t-k} (of k periods lag) can be the result of the correlation of these variables with $Y_{t-1}, Y_{t-2} \cdots Y_{t-k+1}$. To adjust for the effects of this correlation the partial autocorrelation function (PACF) is calculated from the Yule-Walker equations[40].

Thus a stationary ARMA (p,q) process is described by the behaviour of ACF and PACF functions. Generally the ACF and PACF functions are both infinite and tail off as the lag k increases. Both functions are dominated by damped exponentials and damped sine waves.

By using the ACF and PACF functions a model can tentatively be identified, and after its coefficients are estimated, it is subjected to diagnostic tests (comparison of the ACF of the original and estimated series, the examination of the randomness of the residuals, overfitting) to examine its adequacy before used in forecasting.

In this work first and second differencing of the variables was employed, but because of the limited number of the available observations (around 25), only some simple, of low order, models were tried, for example ARIMA (1, 1, 0), ARIMA (2, 1, 0), ARIMA (1, 1, 1), ARIMA (0, 1, 1), ARIMA (0, 1, 2), ARIMA (1, 2, 1). (The models were also estimated with a constant term.) But the results were far from satisfactory.

In most of the estimated models the coefficients were statistically insignificant and the forecasts produced failed entirely to track the data in the sample period, while the 95 per cent forecast limits were very large. The forecast values especially near the end of the sample period were significantly smaller than the actual data[41].

Because of these unsatisfactory results the regression model was employed instead. Each exogenous variable was regressed on its own values lagged by one or two periods, while a time trend was also used. To account for such events as the increase in the price of oil (1974), controls on foreign exchange rates and political changes (1968 France, 1969 Italy) which influence tourists movements, dummy variables were also employed. These autoregressive equations were estimated in levels and in first differences, while they were also corrected for first order autocorrelation. From a statistical point of view (R^2, the magnitude of the Durbin-Watson statistic, and the significance of the coefficients) the most satisfactory results were those derived from OLS estimation with a first order autocorrelation correction. Consequently these equations were used to generate forecasts for the missing years for these three exogenous variables (GTHN, PG/PT_1 and PC/PT_2. It should be also mentioned that for the predictions of these exogenous variables, regressions utilizing their logarithms were also estimated but the results were inferior from statistical point of view (low Durbin-Watson statistic, insignificant coefficients).

10.6 Analysis of the Simulations

Utilizing these predictions of the exogenous variables, forecasts were subsequently generated by the two simultaneous systems (orthogonal and oblique) for the period 1978-1982. Thus the RMSPE were calculated for these endogenous variables over the extended sample 1959-1981.

As Table 2 (Appendix 3) shows the magnitude of the RMSPE for almost every variable has been increased. This result could be expected as, in a dynamic simulation context particularly, the lagged dependent variables take, instead of the actual, the values generated by the model, and hence forecasting errors especially outside the sample used in estimation, tend to build up sharply.

It should be also taken into consideration that the initial conditions are near the beginning of the sample period (1958) and thus the problem of the forecasting errors piling up is further aggravated. Initial conditions chosen nearer the forecasting period (1978-1982) may have diminished these effects and better predictions may have been generated[42]. Despite this it was considered useful to compare the dynamic performance of the two simultaneous systems (with orthogonal and oblique factors) over a long and extended sample, which includes also the years outside the estimated period for which large forecasting errors may occur.

This stringent test has demonstrated that the simultaneous system with orthogonal factors performs better over the extended period as the examination of the magnitudes of the RMSPE for those variables in the two models reveals (Table 2, Appendix 3). For most of these variables the RMSPE, calculated from the system with orthogonal factors, are smaller than those calculated from the system with oblique factors. It should be stressed that the extension of the period of dynamic simulations, to include the forecasting period (1978-1982), has resulted in reversing the performance, measured by the RMSPE, of the two systems, as a comparison of the respective figures of the Tables 1 and 2 verify (Appendix 3. RMSPE figures are calculated up to 1981 as for many data series the figures for 1982 are provisional estimates).

For the period 1959-1977 most of these variables with smaller RMSPE belong to the simultaneous system with oblique factors. But for the extended 1959-1982 the situation is reversed. The oblique factors which are correlated produce larger forecasting errors, which then through the lagged dependent variables (because of the dynamic simulation performed) tend to build up, as the forecasting period increases, resulting in large RMSPE. Thus for the extended period 1959-1981 most of these variables with relatively smaller RMSPE belong to the simultaneous system with orthogonal factors. (But the orthogonal model tracks better, than the oblique one, some of the variables, like GNP, imports-exports during the last years of the sample period 1959-1977 as the figures in Table 4, Appendix 3, show.)

Hence the use of the orthogonal factors has resulted in shrinking the magnitude of the forecasting errors outside the sample period, and consequently the overall results are relatively better than those produced from the use of the oblique factors.

But it should be also emphasised that the simultaneous system with oblique factors still outperforms the system with orthogonal factor as far as the price variables are concerned.

The comparison of the RMSPE figures of Tables 1 and 2 (Appendix 3) testifies that for some of these variables the forecasts generated dynamically from both models are deficient. This is especially true for the price variables.

While the RMSPE for CPI and PGNPM for the period 1959-1977 were respectively 5.29 and 5.13 for the orthogonal and 4.99 and 5.17 for the oblique system, these figures almost tripled when the sample period extended to include the 1979-1981 years. (The corresponding figures for the orthogonal system became 16.71 and 13.96 respectively and for the oblique model 13.50 and 12.50.)

The two models also failed to track down the figures for unemployment for both periods (1959-1977) and (1959-1981) as the large magnitudes of the RMSPE show (Tables 1 and 2, Appendix 3). But the oblique system's forecast for unemployment deteriorated very sharply over the second period. The RMSPE for unemployment from 26.90 for 1959-1977 increased to 35.33 for 1959-1981. (The corresponding figures on the other hand for the system with orthogonal factors are 37.67 and 40.01.)

The RMSPE figure indicates that GNPM is successfully traced over both periods by the two models, a feature shared also by total consumption (TC).

For some of the remaining components of GNP, such as total fixed investment (TFI), total exports of goods and services (X) and total imports of goods and services (M) the RMSPE figures for the system with orthogonal factors, and for the period 1959-1981, are 9.91, 10.14 and 10.49 respectively. On the other hand, for the system with oblique factors, over the same period, the corresponding figures are 10.58, 9.15 and 12.18. For the period 1959-1977 almost all the corresponding figures are smaller as Table 1 shows (Appendix 3).

These figures indicate that the forecasts for 1959-1981 of these variables (TFI, X, M) may not be considered particularly successful. But on the other hand, taking into consideration the volatility of the behaviour of these variables over an extended period of time, as they are influenced by uncertain factors (such as price expectations, future output and profits, economic movements in other countries which could affect exports) and the number of periods over which the dynamic forecasts were generated (1959-1981), their RMSPE figures may be regarded as rather satisfactory.

The RMSPE is regarded as a better performance criterion for a model since it heavily penalises large errors occurring from fluctuations and missed turning points[(43)]. As the simultaneous model with oblique factors exhibits larger errors particularly for the sample which included the years 1978-1982, it was decided to calculate also for both models and for the same variables the mean per cent error (MPE) and the mean absolute per cent error (MAPE) because of the problem of positive and negative errors cancelling out with the former statistic (MPE).

The values of these statistics were calculated from the formulae:

$$MPE = \frac{1}{T} \sum_{t=1}^{T} \left(\frac{Y^s - Y^a_t}{Y^a_t}\right) \quad \text{and}$$

$$MAPE = \frac{1}{T} \sum_{t=1}^{T} \left(\frac{|Y^s_t - Y^a_t|}{Y^a_t}\right) \quad \text{where}$$

Y^s_t and Y^a_t are the simulated and actual value of the variable Y at time t and T is the number of periods in the simulation (forecasting).

The results are presented in the Tables 5 and 6 (Appendix 3) for the MAPE and MPE respectively.

While there are obviously differences in the values of RMSPE and MAPE, and some insignificant changes in the relative performance of few variables, between the two models, in the period 1959-1977 have also occurred, the conclusion derived from the figures of the RMSPE has been corroborated. That is the oblique model performs better, although not substantially in the estimation period (1959-1977), but outside this period, the forecasts it generates, relative to those of the orthogonal model, are less robust and subject to larger errors, as the figures of MAPE of the two models for both periods demonstrate (Table 5 in Appendix 3).

This picture is reinforced from the results of the MPE shown in Table 6 (Appendix 3). The forecasts generated by the orthogonal model are more stable in the sense that the estimates of MPE for the variables, fluctuate less over the two periods for the orthogonal than the oblique model. Moreover the orthogonal model underpredicts (negative figures of MPE) about half of the variables and overpredicts the remaining (positive figures of MPE) for both periods. At the same time the oblique model underpredicts almost all the variables in question in the period 1959-1977 (only disposable income (DY) and the interest rate (RL) are overpredicted) and most of them during the period 1959-1981 as the figures in Table 6 (Appendix 3) demonstrate.

Considering all the above results, as it has been already stated the model with the orthogonal factors performs better over the extended period 1959-1981 than the model with the oblique factors, and it is less satisfactory from the latter over the period 1959-1977 though their differences in this period are relatively less considerable than their differences in the former period 1959-1981.

It should be also mentioned that the oblique rotation of the factors was quite arbitrary. That is the parameter δ, which controls the oblique rotation, was given a sequence of values (usually in the range -1 to 1 in steps of 0.1) and the value of δ, which resulted in factors with a rather clear and simple pattern, was finally chosen to determine the oblique rotation and the matrix of factor loadings. (That is the value of δ was chosen on the basis that the generated components could be given a meaningful economic interpretation and could also have correlations which, to some extent, would resemble those encountered between economic variables.) This matrix was subsequently used to calculate the factors used in the reduced form regressions. But this pattern of the factors could have been also attained or approximated with different values of δ, although close to the one chosen. The various values of δ would have resulted in different matrices of factor loadings and hence different estimates of the oblique factors which could be used to estimate the reduced form equations. Consequently a proper procedure to assess the effects of the oblique factors would be to use different estimates of them. But as this procedure posed a substantial computational burden, with probably not significantly different results, it was not attempted.

Taking also into account the importance for a model of its forecasting performance outside the sample period, it was finally decided to prefer the simultaneous system with orthogonal factors for the estimation of the reduced form parameters. This model was also used in the first stage of the 2SLS with principal components estimation of the structural equations in the model. (The estimates of the selected reduced form equations, with some systematic differences concerning the estimates of the other reduced form models, are given in Table 19, Appendix 3.)

Analysing in some detail the behaviour of GNP at market prices, its main components (TC, TFI, X and M), the two price variables (CPI, PGNPM) and unemployment (UN), for the period 1959-1982, of the finally selected model we can observe from Table 4 and the relevant graphs (Appendix 3. The graphs follow Table 11) the movements of the simulated and the actual values of these variables. (The simulated values of the simultaneous model with oblique factors are also given for comparison in the same table.)

The RMSPE, which is a measure often used in practice to evaluate the simulation performance of a model, has been also used in this study. This measure heavily penalises the large errors between the simulated and the actual values of the variables, more than other measures also employed in practice such as the mean per cent error (MPE) and the mean absolute per cent error (MAPE) as it has been already mentioned.

As the RMSPE for total consumption (TC) for 1959-1981 is very low (3.89), it indicates that the simulated values are very close to the actual ones. Although the simulated values of total consumption start as early as 1959 the model traces actual consumption very closely up to 1966, with the exception of 1965 when it overpredicts consumption expenditure by about 7%. This difference is due to the failure of the consumption of nondurables (CND) and of services (CS) functions to track down satisfactorily the data. (The first overpredicts CND by 4 billion, and the second CS by 5 billion drs.) This result can be attributed mainly to a reduction in that year in the value of the component associated with variables expressed in nominal terms. The simulated values approach actual total consumption in 1966.

For the next year (1967) the model overpredicts consumption by a figure of 6%. For this year the CS function again exagerates consumption of services by 5 billion drs. But in 1967 the simulated value of the consumption of durables (CD) is 4 billion drs. in excess of the actual one.

Because of the political turmoil of the previous year and the abrupt change of the regime in 1967 (mentioned in the introductory chapter) an intensified climate of uncertainty may have prevailed, the outcome of which may have influenced expenditure plans and result in the slackening of the rate of consumption expenditure. In this case the consumption expenditure on some items included in the CD and CS categories is more liable to reduction. A further indication to the explanation that the general political climate in those years has slowed down some forms of expenditure is that consumption of durables increased by a small amount (relative to previous years) between 1966 and 1967 (from 28.2 to 29 billion drs.).

The deviations between simulated and actual values of total consumption were decreased between 1968 and 1971 (except for 1969 when simulated values are higher because the model overpredicts the upturn in CS and CD).

Although the model follows the increasing trend for 1972 and 1973, it fails to match the sharp increase in total consumption in those two years of intense economic activity before the oil crisis. (The failure comes from all three consumption functions. The simulated values continued the upward trend in the next year (1974) when approached the actual figures for total consumption which reduced from 259.3 to 257.6 billion drs. For the next four years both actual and simulated values follow the same trend with small deviations until 1978 when they almost equal. Actual consumption increased between 1978-1979 by 8 billion drs and then remained almost stable until the end of the extended sample period. On the other hand simulated total consumption shows a large increase in 1979 (all the consumption functions demonstrated a uniform pattern of increase in that year). Then simulated values decreased in successive years to approach the actual values at the end of the extended sample period.

Total fixed investment (TFI) simulated values follow closely the actual values from 1959 to 1966 as Table 4 (Appendix 3) demonstrates, except for 1960 when actual TFI increased from 25.3 to 29.1 billion drs, while the simulated values showed a decrease of 3.5 billion drs (from 26.5 to 23 billion drs). Each of the three functions for fixed investment, housing (HI), construction (CI) and equipment (EI) underpredict the actual values by 1.5 to 2.5 billion drs (around 20%).

In 1967 actual investment took a downturn although by a small amount (from 50.6 to 49.8 billion drs) affected by the political events of that year (mentioned in the introduction). Construction and equipment investment remained almost stable between 1966 and 1967 (from 19.1 to 19.4 and from 15.9 to 16.5 billion drs respectively) while housing investment decreased by

1.6 billion drs (almost 10%). Simulated fixed investment, on the other hand, missed this downturn. Simulated housing investment showed a small increase but the other two fixed investment simulated larger increases. A decrease in housing investment in 1970 was not predicted by the model, which otherwise follows closely the pattern of the actual values of the three fixed investment functions between 1968 and 1971.

As with total consumption, the model did not adequately simulated the sharp increase in the economic activity and hence on investment expenditure between 1972-1973. But, importantly, it captured the large downturn in fixed investment in 1974 and the subsequent slack in the rate of investment between 1975 and 1977 as Table 4 (Appendix 3) demonstrates. (Actual investment for 1974-1977 was 74.5, 74.7, 79.7 and 85.9 billions while the corresponding figures for the simulated values were 74.6, 76.5, 78.9 and 89.0 billion drs.)

For the four years outside the sample period (1978-1981) investment does not perform quite satisfactorily. Although it traces the increasing pattern of investment for the first two years (1978-1979) and the continuous decrease in the remaining years, the deviations between simulated and actual values are considerable. In 1978 the model overpredicts investment by 14% arising almost equally from all the trace functions. For 1979 the deviation between simulated and actual investment amounts to 20% due mainly in the overprediction for the equipment investment (actual value 38 and simulated 50.5 billion drs). For the remaining years, although the downward trend is captured and the percentage of the deviations between simulated and actual values of total investment decreased to around 10%, the differences in the forecasts of the disagregated investment functions are concealed. For 1980 the three fixed investment functions forecast adequately well with the equipment investment the least satisfactory. In 1981 only the construction investment predicts satisfactorily while equipment investment overpredicts by an amount of 10 billion drs (simulated value 44.7 and actual 34.9 billion drs) which is offset by the large reduction predicted for housing investment.

Actual total exports of goods and services (X) follows an upward almost smooth trend up to 1971 which is almost captured by the simulated values of the model. The exception was in 1963 when a small decrease is predicted. This decrease arises entirely from the downward prediction of the exports of goods function (XG) in that year, and can be attributed to the relatively sizeable decrease in the component associated with the variables in nominal term and the increase in the component associated with prices. The slight decrease in exports in 1967 is not predicted by the export functions which remained almost stable as the increase they predict for 1967 was very small.

The export functionsfollow the pattern of the other variables, discussed above, for the years 1973-1974 by predicting the increase in exports but not matching the magnitude of that increase. On the other hand the decrease in actual total exports in 1974 is due entirely to the fall in the export of services, which is captured, but not to the same extent by the model. (Actual exports of goods increased between 1973-1974 from 32.4 to 34.4 billions while the simulated values show an increase from 27.5 to 32.5 billion drs. Actual exports of services decreased in the same period from 18.4 to 13.7 while simulated ones from 14.5 to 11.3 billion drs).

The years 1974-1977 are simulated satisfactorily by the model as Table 4 (Appendix 3) shows. Moreover the values of the exports of goods are very closely tracked by the model (the actual values of exports of goods for this period were 34.4, 37.7, 43.9 and 43.3 billions while the corresponding simulated values were 32.5, 37.3, 43.0 and 43.7 billion drs).

The relatively large discrepancy between simulated and actual values of total exports in 1978 arises mainly from the exports of services functions, while for the next two years the model almost reproduced the values of total exports (Table 4). The close, to actual values, prediction for 1981 conceals the fact that the export functions fail to simulate successfully the data. The export of goods function overpredicts the actual data by a large amount, which is almost offset by the amount by which the exports of services functions underpredict the actual data.

The import functions follow generally a similar, to that of the export functions, pattern in tracking rather satisfactorily the actual data from 1959 to 1972 with the exception of 1963 when a downturn is wrongly predicted. The downturn is mainly predicted for the imports of oil function (M3) which is strongly affected by the changes in the two components mentioned previously for the export functions. (For 1967 simulated imports overpredict the actual ones, while the latter, although influenced by the events in that year, showed only a small increase. Actual imports rose from 37.9 in 1966 to 40.7 billion drs in 1967 while the corresponding figures for the simulated imports were 39.4 and 44.5 respectively.)

The increase between 1972 and 1973 which the model predicted was not sufficiently comparable to the large rate of increase of actual imports during these years. At the same time however, the model predicted the downturn in imports which occurred in the next year (1974) and then traced closely the actual data up to 1980, except for 1979 when simulated imports exceeded actual ones by 10 billion drs or around 9.5% (actual imports were 104 and simulated 114 billion drs). The main source of this deviation comes from the imports of machinery (M7) which over-predicts actual imports of M7 by 7 billion drs. This was mainly the outcome, on the one hand, of a sizeable increase in the principal component associated with the variables in real terms, and on the other hand of the failure of the price equations in the model to approach the actual values of prices especially after 1975. The result of this failure was a small change in the values of the component associated with prices which was further intensified by the small coefficient of this component in the M7 function which function consequently overpredicts the actual imports of machinery.

It should be also pointed out that the import of services showed a larger rate of increase in the last years covered by the sample relative to that of the imports of goods (a feature shared also by the exports of services). But they were also more volatile in their behaviour especially after 1974 and thus it was harder to simulate them successfully. The figures for 1981 substantiate it, as they show a large decrease in total imports, which for the largest part is due to the failure of the imports of services functions to simulate satisfactorilythe actual values of this year (Table 4, Appendix 3).

Both the consumer price index (CPI) and the implicit deflator of GNP at market prices (PGNPM) function inaccurately predict a decrease in these prices for 1963, the result mainly of large but opposite changes in the components associated with the variables in nominal terms (increase) and the prices (decrease). In general both CPI and PGNPM follow the slowly increasing trend of the actual values between 1959 and 1972, although they remained stable between 1967 and 1968 when actual prices picked up some points. The leap of the simulated values of CPI and PGNPM between 1972 and 1973 was not enough to trace closely the sharp increase in CPI and PGNPM in 1973. For the next three years up to 1976 the model simulates rather satisfactorily the values of the CPI and PGNPM.

From then on up to the end of the extended sample period (1981) the simulated values were trailing behind the actual ones and the simulation results by far worsened outside the sample used in estimation (1954-1977) as Table 4 (Appendix 3) demonstrates. Both price variables continuously and increasingly diverge and underpredict the actual ones. It should be pointed out that these large deviations, the result of the underprediction of the actual values, are generated, not only by CPI and PGNPM but by all the prices functions in the model. These large deviations of the price variables in the last years of the sample have serious consequences for the simulating and forcasting power of the model. Because of the underpredictions of the individual price functions the principal component associated with them is consequently underestimated. But in apart from this direct results there are also other repercussions. The generated by the model values of the deflators are used to calculate the respective variables in nominal terms, which as a result are also underpredicted. The underpredicted variables in nominal terms have large loadings on the component that is associated with them, which consequently is also underestimated.

As this factor has a large and significant coefficient in many reduced form equations for prices, the generated under-predictions of prices feedback, through these two factors, in the estimates produced by the model and errors are accumulated as the number of periods used in the forecasts increases.

But these two factors have also large and significant coefficients in other reduced form equations of the model. Thus such large deviations for a number of periods in the prices are spread in the other sectors of the model not only directly through these two components but also through the feedbacks generated by the structure of the model. That is the simulated values, through the lagged dependent variables of the model, influence the generated values of the next period for all the endogenous variables in the system.

The inertia showed by the price equations which resulted in their failure to approach the actual prices since the mid 70's when rapid inflation occurred, calls into question their specification. Different forms of specification such as equations in differences of the variables might have been experimented with. However this would require re-estimation of not only the relevant equations but also the computation of new principal components, orthogonal and oblique, necessary for the equations of the reduced forms and simulations with a larger number of models. But because of time limitations these attempts were precluded.

The simulated value of GNP at market prices under-predicts the actual figure by 7% in 1960 and arises mainly from the downturn in fixed investment (analysed above) by the model in that year. The fall in total exports and imports, as explained previously, which the model predicts for 1963 coupled with an underprediction of inventory investment (II) are the main sources of the underprediction of GNP by 7% also in 1963 (actual GNP in 1963 was 181.5 billion and the simulated value 168.7 billion drs).

Between 1959 and 1971 the model generally overpredicts GNP but deviations between simulated and actual values exceeding a moderate figure of say 5%, were those in 1967 (9%) and 1969 (7%). The political events in 1967 may have slackened the pace of economic activity in that year, while the overprediction of consumption and fixed investment in 1967 and consumption and inventory investment in 1969 were the main sources of the deviations between simulated actual values in those years. The sharp increase in economic activity recorded in 1972-1973 is not matched by the increase for these two years predicted by the model, which subsequently missed the decrease of GNP in 1974 (from 379 to 369 billion drs) although the deviation between simulated and actual values in that year is small (actual value 369 and simulated 374 billion drs).

For the following years up to 1982, the simulated values of GNP exceed the actual ones and coincide almost with the latter values at the end of the period. But these deviations do not exceed 5% except for 1979. In this year the simulated value of GNP is 13% in excess of the actual one, and all of GNP components (except total exports) are the sources of this deviation.

In 1979 the second wave of the oil price increases occurred with serious repercussions on world economic activity. As the model is estimated using data up to 1977, the effects of the new increase in the price of oil cannot be captured by the use of a dummy variable.

On the other hand, the failure of the price equations to approximate in a dynamic simulation context the actual values, as it was analysed above, has prevented the effects of the large increases in the prices which occurred in that year to be transmitted through the structure of the model and affect theother sectors of it, thus depressing the increases generated by the model in 1979.

The simulated values of unemployment (UN) show a large increase in the number of unemployed for 1960 and 1961, while actual figures recorded a decrease in unemployment. The prediction by the model of a decrease in GNP in 1960 is reflected in the considerable increase of unemployment which was predicted by the model for that year. Although the simulated values closely follow the actual ones for 1962 and 1963, for the following three years (1964-1966), when unemployment remained stable at 65 thousands, the model predicted a large increase in the number of unemployed for 1964 and 1965 (104 and 91 thousands respectively).

The failure of the model to capture the slack in the economy in 1967 is reflected in the result of the simulation. The model predicts a small decrease in unemployment from 68 to 64 thousands, while the number of unemployed actually increased from 65 to 84 thousands.

For 1968 to 1970 when the model overpredicts GNP the decrease in unemployment, forecasted by the model, is greater than the actual occurred. (The original figures for those years were 74, 67 and 49 thousands while the simulated values were 69, 46 and 40 thousands respectively.)

On the other hand for 1971 to 1973 the opposite picture emerges. As the model underpredicts GNP it also underpredicts the decrease in unemployment, as Table 4 (Appendix 3) shows. The model successfully predicted the increase in unemployment for 1974-1975, but while unemployment remained almost stable (between 28 and 32 thousands) in the period 1976-1979 the model predicted a significant decrease from 42 to 15 thousands. The low value (15 thousands) in 1979 coincides with the large overprediction in GNP for the same year by the model. For the remaining years 1980-1982 unemployment started climbing again, a fact that is also predicted successfully by themodel.

Although the model after 1966 predicts satisfactorily the upward and downward movements in unemployment and forecasts almost all the turning points (except in 1978), a significant result for such a volatile variable, the case should not be overstated because, even after 1966, the deviations between simulated and actual values of unemployment are very large.

The mean absolute error (MAE) was also calculated for the same variables, and the results are presented in Table 7 of Appendix 3 (together with the MAE for the system with oblique factors, for comparison), while in Table 8 (in the same appendix) the means of these variables are also shown.

The inspection of these tables confirms what has been already stated about the differences between the two simultaneous systems with orthogonal the one and oblique factors the other. The latter tends to generate larger errors when the sample is extended in the simulations to include the forecasting period (1978-1982). The estimates of the oblique model show that the mean absolute error increases not only relatively to the corresponding values of the model with orthogonal factors but, for some variables, even in absolute terms (e.g. GNPM, M, DY).

On the other hand the forecasts generated by the model with orthogonal factors were again proved more robust to the enlargement of the sample as the estimates of MAE point out.

At the same time the mean absolute error for each variable is not quite large and compares satisfactorily with the corresponding means, as the figures in the Tables 7 and 8 (Appendix 3) show, with the exception of the prices, unemployment and nominal imports (MV) and exports (XV) for which their MAE (for 1959-1981) are very large compared to their means.

From the above analysis it has been indicated that a dummy variable could have been tried to capture the effects of the political changes in 1967 and may have improved the simulated values. But when a dummy variable was tried in some structural equations it had a very small effect. Hence it was problematic whether had a dummy variable been kept, it would have produced some significant improvement in the results.

At the same time the price increases in the last years of the sample used in estimation, and particularly the increases in the subsequent period 1978-1982, intensified by the second increase in the price of oil, were very large and the model could not have been expected to trace closely that steep upwards trend in prices, especially in a dynamic simulation context (with the initial conditions in 1959).

However the predicted prices by themodel from 1976 are disappointingly low, their deviations from the actual prices are very large with serious repercussions for the forecasts of the other endogenous variables generated by the model.

On the other hand and despite these shortcomings the simulations of the model for GNP, and most of its main components, over a large number of years, could be regarded as satisfactory as the values of the RMSPE and MAE of these variables indicate.

10.7 Forecasts 1978-1982

The aforementioned results are related to the outcome of the dynamic simulations inside the sample period (1959-1977) and the dynamic simulations of the extended sample (1959-1982) which included the forecasting period 1978-1982.

But forecasts were also generated for the years 1978-1982, outside the sample period, with initial conditions those of the year 1978.

Two sets of forecasts were generated, dynamic ones in which the model uses for the lagged endogenous variables, the values that it generates (designated as SIMA in Tables 9, 10 and 11, in Appendix 3) and static forecasts (designated as SIMB) in which the actual values for the lagged endogenous variables were used.

The actual values and those of these two types of forecasts, for the same variables included in Table 4 (Appendix 3), are presented in Table 9 in the same appendix. (In both tables 4 and 9 the values for the year 1982, both actual and forecasted, were not used in the calculation of the statistics RMSPE and MAE because for some variables, like fixed investment, the data used are provisional.)

The simulation error increases as the length of the simulation period extends. More important, as studies have shown, the error increases much more considerably when the equations of a model are extrapolated outside the sample period. The extrapolation error is two or three times larger than the simulation error within the sample(44).

This is refelcted in the estimates of the Mean Absolute Error (MAE) for the periods 1978-1980 and 1978-1981 for most of the variables included in the Table 11 (Appendix 3) which are compared (Table 7, Appendix 3) with the estimates of these variables of the simultaneous system with orthogonal factors for the periods 1959-1977 and 1959-1981.

Almost the same picture emerges when the figures for the Root Mean Square Percentage Error (RMSPE) are compared. But in this case it can be also observed of which variables the forecasts have deteriorated relatively more outside the sample (see in Appendix 3, Tables 1 and 2 for the RMSPE of the simultaneous system with orthogonal factors for the periods 1959-1977 and 1959-1981 and the RMSPE in Table 10 for the forecasts SIMA and SIMB for the periods 1978-1980 and 1978-1981).

This comparison shows that, in percentage terms, a relatively uniform deterioration of the forecasts outside the sample period has taken place for most of these variables. Comparing the figures of the RMSPE of dynamic simulations inside the sample 1959-1977, with the RMSPE of the dynamic forecasts (SIMA) for the period 1978-1981, it can be seen, that for most of the variables the RMSPE has been almost doubled or even more. For example the RMSPE for GNPM increased from 4.93% to 8.52%, for total consumption (TC) from 3.80% to 6.65% for total imports (M) from 8.40 to 16.37% and for total fixed investment (TFI) from 8.41% to 14.68%.

In accordance with the failure of the model to track satisfactorily the price indices for the last two years of the sample period, especially for the subsequent years when the sample was extended up to 1981, the price variables PGNPM and CPI, performed disappointingly, as it would be expected, when forecasts generated outside the sample period, as the figures of the RMSPE show in Table 10 (Appendix 3).

At the same time, the exports of goods (XG), total exports (X), and imports of goods (MG) performed better, as the figures of the RMSPE for the forecasts in 1978-1981 are lower than the corresponding figures for the RMSPE of the simulation inside the sample period. (In Appendix 3, Table 10, figures of SIMA 1978-1981 and Table 1, figures for the simultaneous systems with orthogonal factors.)

In Table 9 (Appendix 3), the detailed year by year figures of the two types of forecasts (SIMA and SIMB) for 1978-1982 are presented, together with the actual values, for the same variables included in Table 4 (Appendix 3).

As it has already been explained, concerning the analysis of the results of the simulations presented in Table 4 (Appendix 3), the failure of the model to track dynamically the price variables, between 1976 and 1982, is not surprising as their values doubled or more after the estimated period. For example the PGNPM which had the value of 231 in 1977 (last year included in the estimation period) reached 551 in 1982; CPI from 228 in 1977 increased to 576 in 1982, while some other price indices, as those of investment categories, increased even more (base year for the price indices 1970).

The result of these low simulated values for the price variables, is that the figures for the principal component of prices are seriously underestimated in the dynamic simulations for these years. Not only that, but as the nominal values of the variables are produced by multiplying the volume figures by prices, the underestimation of the latter leads to underestimation of the nominal values as well. Consequently the figures for the principal component of nominal variables is also underestimated.

For 1978 the models underestimate GNPM by 21.3 billion drs., 4.6% (actual GNPM 458.7 billion forecasted 437.4 billion drs.) while at the same time the model predicts fairly closely almost all the components included in GNPM. The actual figures for TC, TFI, X and M were 324.8, 91.1, 75.1 and 98.3 billion drs respectively, and the corresponding forecasted figures were 323.5, 98.0, 65.4 and 100.0 billion drs. In this year the model overpredicts investment by 7 billion drs and underpredicts total exports by about 10 billion drs. But the item mainly contributing to the underprediction of GNPM is inventory investment (changes in stocks). The actual figure for changes in stocks in 1978 is an increase of 15.6 billion while the model predicts a decrease in stocks of 2.6 billion drs. This very poor prediction for inventory investment is the outcome, as it has been already explained, of the large coefficients of the principal components for nominal variables and prices in the reduced form equation for inventories in conjunction with the large values which these two components have in 1978, (the initial conditions for the forecasts SIMA), when the actual figures of the price indices used are very large (compared with those the model generates in the simulation for 1959-1982).

In 1979, when the model employs for the lagged endogenous variables the figures it generates, it underpredicts considerably the prices (as in the case of simulations for the period 1959-1982); it results in values for the endogenous variables in excess of the actual ones.

This outcome was intensified by the fact that, while in 1979 the second wave of oil price increase occurred, the model estimated up to 1977, was not adjusted for that. Thus the model overpredicts for 1979 not only GNPM but also all its components. As the figures in Table 9 (Appendix 3) indicate, GNPM is overpredicted by 9.2%, while TC is overpredicted by 6.8%, TFI by 22%, M by 19%, inventory investment by 70% (actual changes in stocks 18.1 billion and predicted 30.8 billion drs) and exports are underpredicted by 1%.

At a more disagregated level, the most unsatisfactory forecasts were generated by the functions of consumption of durables (CD), the fixed investment functions especially that for equipment investment (EI), the imports of machinery (M7) and the function for the payments for transport and other services (PTOS).

The model overpredicts total consumption by 22.7 billion drs and from that amount 12.5 billion drs came from the over-prediction of the CD function (for 1979 the CD function overpredicts the expenditure as durables by 16.4% - actual value 76 predicted 88.7 billion drs - while the other two consumption functions overpredict CND and CS expenditure by 2.5% and 6.1% respectively).

Total fixed investment, as studies have shown is the component of GNP most difficult to predict and has larger percentage forecast error than other components of GNP for example consumption expenditure[45]. In all the simulations in this study (as it can be seen from the RMSPE figures, of Tables in Appendix 3) the RMSPE for total fixed investment is relatively one of the largest among the components of GNP. For 1979 all the three fixed investment functions overpredict the actual values of investment categories, especially the equipment investment function. (Housing investment is overpredicted by 5.6, construction investment by 6.0 and equipment investment by 11.1 billion drs, and in percentage terms by 17.7%, 21% and 29.2% respectively.)

While the functions for the export of goods and services predict the actual values very closely (actual value of the export of goods 52.1 predicted 54.7 billion drs. For total exports of goods and services the corresponding figures are 81.0 and 80.1 billion drs), the predictions of some of the import functions are unsatisfactory. The model overpredicts total imports of goods by 7.3 billion drs (8.7%). From the six functions for the import of goods three of them (M01, M56 and M89) overpredict and under-predict imports by less than one billion drs each. (The actual and predicted values for these import categories are 9.1 and 9.8, 21.1 and 20.5, and 3.4 and 3.5 billion drs respectively.) The other three import functions M24, M3 and M7 do not predict satisfactorily the figures for 1979 to different degrees. Actual imports of M24 are of a magnitude of 6.3 while the model predicts a value of 8.6 billion drs. For M3 (fuel imports) the corresponding figures are 20.9 and 18.1 billion drs. The function for the imports of machinery (M7) is the most unsatisfactory. While the actual value of imports for M7 is 23.0 billion drs the predicted value is 30.6 billion drs. The other function which contributes to the overpreidction of the value of total imports of goods and services is the function for payment for transport and other services (PTOS). The actual figure for PTOS in 1979 amounts to 15.4 billion drs while the value predicted is 28.2 billion, an excess of 12.8 billion drs. Thus the functions which perform least satisfactory for 1979 are CD, the investment function, especially that for EI, inventory investment, the function for the import of machinery (M7) and the one for PTOS. Expenditure on consumption of durables and equipment investment are heavily dependent on imports, and the worsening of the terms of trade by the oil price increase in 1979 led either to small decreases in some import categories or to a decrease in the rate of growth of others. As part of the consumption and especially part of the investment (particularly equipment investment) depend on imports, the model was not able to track down the effects of these import changes on the components of GNPM, because the second wave of the price of oil increases have not been incorporated. As an indication of the probable effects of the oil price increases, it should be mentioned that of all the import functions in the reduced form equations, M7 and PTOS have very large, negative coefficients for the dummy variable D74 which accounts for the effect of the oil price increase in 1974 (Table 19, Appendix 3). D74 has also large negative coefficients in the consumption of durables and equipment investment functions (Table 19, Appendix 3).

For 1980 the model overpredicts GNPM by 8.7% (actual 483 and predicted 525 billion drs), while the prediction error for most of the components in GNPM is considerably smaller, especially those for TFI and imports of goods. Total consumption is overpredicted by 18.5 billion drs (5.5%), total fixed investment by 8.7 billion drs (9.7%), imports of goods are underpredicted by 0.3 billion drs (0.4%), total imports of goods and services are by 14.7 billion drs (15%), and total exports of goods and services are also under-predicted by 1.4 billion drs (1.6%).

The inventory investment function behaves very badly for 1980 as well, by underestimating that year's changes in stocks by 9 billion drs (48%).

The disaggregated analysis of the forecasts for 1980 not only shows the particular contributions of each item of expenditure to these forecasts but it may also point out to the factors that give rise to these deviations of the forecasts from the actual values. In total consumption (TC) the main cause of the deviations is the consumption of durables function. From the 18.5 billion drs by which the model overpredicts TC, 17.4 billion drs is due to the forecast error of CD (the forecast error for CND is -0.2 and for CS is 1.4 billion drs).

The forecasting error for construction (CI) and equipment investment (EI) has been decreased compared with those of 1979, thus contributing in a smaller forecasting error for TFI (forecast error: for CI 6.0 billion drs in 1979 and 4.7 billion drs in 1980 and for EI 11.1 billion drs in 1979 and 8.8 billion drs in 1980). But the significant decrease in the forecast error of TFI to 8.7 billion drs in 1980 from 22 billion drs in 1979 is also due to the underprediction of housing investment.

While housing investment was overpredicted in 1979 by 5.6 billion drs the reverse situation occurred in 1980 when HI was underpredicted by 4.9 billion drs. The forecast error in HI is caused not only from the effects of the principal components for prices and nominal variables due to the underprediction of prices of the model, which also influences all the other functions, but also from the effects of the substantial devaluation of the exchange rate which significantly affects other variables as well.

From 1954 to 1974 the exchange rate was fixed to 30 drachmae per U.S. dollar, while for the last three years in the sample period used in estimation, the exchange rate was 32.4 drs in 1975, 36.2 drs in 1976 and 37.2 drs per U.S. dollar in 1977. In 1978-1979 the exchange rate remained at almost the same level, but for the next three years the country's currency was devalued (42.6 drs in 1980, 55.4 drs in 1981 and 66.8 drs per U.S. dollar in 1982).

The reduced form housing investment function is strongly influenced by the exchange rate. As this variable has a large (negative) coefficient, the effect of the devaluation in 1980 was a significant underestimation of housing investment (actual value 27.3, predicted 22.40 billion drs). The magnitude of the coefficient of the exchange rate in the reduced form equation for HI is -1731, one of the largest in all reduced form equations, especially compared with the coefficient of exchange rate in the other investment functions (Table 19, Appendix 3).

The forecast errors of the export functions are very small in absolute or percentage terms, except for the earnings from tourism function (ENR) which underestimates earnings rather significantly (exports of goods are overestimated by 1 billion drs, 1.7% and transport and other services receipts (RTOS) are also overestimated by 0.1 billion drs, 1.3%, while ENR is underestimated by 2.5 billion drs, 12.9%).

The effect of the devaluation in 1980 has mainly influenced the import functions M01 and M7. Total imports of goods are underestimated by 0.3 billion drs, 0.4%. (In detail, M01, M24 and M89 are underestimated by 4.5 billion drs, 53.6%, 0.02 billion drs, and 0.1 billion drs, 3% respectively. On the other hand M3, M56 and M7 are overestimated respectively by 1.1 billion drs, 5.7%; 0.9 billion drs, 46%; and 2.3 billion drs, 10.8%. M7 in 1979 was overpredicted by 7.6 billion drs.) But the effect of devaluation on the import of services functions had severe consequences on the forecast error of these functions which is very large, contributing to a considerable underestimation of total imports of goods and services by 14.7 billion drs, 15% (the actual figure for PTOS is 15 billion drs, while the forecast value is only 2.6 billion drs. For the expenditure of the country's residents abroad (ERA) the model's prediction is 2.7 billion drs while the actual figure is 4.7 billion drs).

The increase in the length of forecasting period diminishes the forecasting accuracy of a model,[46] as the accumulated forecasting error increases. The effect of lengthening the forecasting period has been gravely aggravated in this case, by the further devaluation in 1981 when the exchange rate reached 55.4 drs per U.S. dollar.

Most of the import functions (except M89), depending on the magnitude and the sign of the coefficient for the exchange rate (particularly relative to the magnitude of the variables involved) have had large forecasting errors, especially those for services, bringing the total underestimation of import of goods and services to 22.5 billion drs, 15%. (The import of goods showed a smaller underestimation of 4.5 billion drs, 5%, but this figure conceals the different movements in the forecasting error of the various imports of goods functions, cancelling each other.)

On the other hand, because of the positive effect of exchange rate variable, export of goods are overestimated by 18.6 billion drs, 32.9%, while total exports of goods and services are overestimated by 7.3 billion drs, 8.4% because of the opposite direction in the forecasts for the export of services.

For construction investment the forecasting error remained almost at the same level (4.5 billion drs), while for equipment investment the forecast error increased to 14.4 billion drs (actual 34.9 billion, predicted 49.3 billion drs). But for housing investment the effects of changes in the exchange rate was extremely severe, as its forecast was 6.4 billion drs in 1981 while the actual figure reached 24.9 billion drs.

A high percent of the forecast error for GNPM is attributed in 1981 as well to inventory investment. Changes in stocks were increased in 1981 by 11.7 billion drs while the forecast was 29 billion drs, an overprediction of 17.3 billion drs.

Consumption of durables which continued to be over-predicted by themodel reached 90 billion drs in 1981 while the actual figure was considerably lower, to 70 billion drs. On the other hand the model tracks very closely the expenditure on consumption of non-durables and services. Actual expenditure in 1981 for CND and CS was 156.8 and 109.6 billion drs respectively, while the corresponding forecasts were 164.3 and 115.2 billion drs, overpredicted by 4.8% and 5% respectively.

The analysis of the forecasts for the period 1978-1981 indicates the need for adjustment, so that the forecasts could be improved[(47)].

In actual forecasting situations, apart from constant adjustments to take into account the error properties of the model, information concerning structural shifts, changes in tax laws, strikes, and new economic policies are taken into consideration so that predictions may be improved.

The forecasting period 1978-1982 was a turbulent one, with many changes in world economy which had serious repercussions for the economy so that various policy measures had to be taken. All these changes should be taken into consideration when examining the forecasts generated by the model.

During this period oil price was increased for the second time followed by increase in other prices. Between the last year in the estimation period (1977) and 1982 all the price deflators (base year 1970) more than doubled while the currency was devalued successively from 37.2 in 1977 to 55.4 drs in 1981 and 66.8 drs per U.S. dollar in 1982. Moreover other measures were taken to encourage the export sector and to check the rise of certain categories of imports, such as luxurious goods included in the category of durables (CD), travelling abroad etc. Their combined effect during this period was a large range of changes in many economic magnitudes which could not be closely tracked down by the model for each year.

As the main interest was to explore how the model responds when the relationships it embodies are exposed to the actual conditions prevailing in the years 1978-1981 (outside the sample period) no adjustments were attempted.

It should be again stressed that the consequences that the underprediction of prices by the model has on the principal components, especially of nominal variables and prices and hence on forecasts. This is indicated by the predictions (SIMB) generated by the model when the actual values for the lagged dependent variables are used.

As it can be seen in Table 9 and the graphs which follow it, in Appendix 3, the SIMB predictions are very close to the actual figures for 1978-1979. (For some components of GNPM the SIMB forecasts in 1980 are also close to actual figures. But after 1980 the combined effect of the large prices prevailing in the economy and the large devaluations relative to those during the estimation period set the SIMB forecasts off track for all variables except prices.)

Concluding, despite these large changes in the years 1978-1982 and although no adjustments were made, the model even in a dynamic forecast context, predicts fairly closely many of the components of GNP for three, and for some variables four years ahead, as the above analysis at aggregated and disaggregated level has indicated.

10.8 Multipliers Properties

To examine the dynamic response of the relationships in the model to changes in specific variables the dynamic multipliers associated with changes in the exogenous variables were calculated.

Although a model may not produce very reliable predictions, dynamic simulations performed may show what the time path of the endogenous variables, induced by policy changes, is going to be[48].

The calculation of the multipliers could also reveal the methametical properties of the model, that is whether the multipliers exhibit oscillations, whether these oscillations are damping and whether they eventually converge. These results may indicate the need for respecification of some relations in the model.

The policy simulations performed were the following: a) an increase in the government real expenditure (GCE) on goods and services by 1 billion drs in 1969, b) a 10% devaluation in 1969 in the exchange rate (from 30 to 33 drs per U.S. dollar) and c) a 1 percentage point increase in the Bank of Greece discount rate (DIRA).[49] The multipliers were calculated by comparing the two dynamic simulations of the model over the same period (1969-1980), that is the one computed by using the actual values of the exogenous variables (control solution) to the other in which the value of the above exogenous variables, each at a time, was changed for 1969 only. The multipliers for the endogenous variables of interest were then computed by calculating the difference between the two simulation solutions (the one produced by giving a stepwise change to exogenous variables minus the one produced by using the actual values of the exogenous variables. This difference was then normalised by dividing it by the step increase in the policy variable each period. Thus the dynamic multipliers were computed by

$$\frac{\Delta \text{ in endogenous variables}}{\Delta \text{ in the policy (exogenous) variable}}$$

The purpose of the simulations was to examine the degree of stability of the model to sudden shocks in the exogenous variables and to test whether they dampened or amplified, which endogenous variables respond more and by what amount.

Thus the step change in the exogenous variables was not sustained and no adjustments were made for supply constraints or to accommodate some of the effects of these changes.

The dynamic multipliers for the three simulations are calculated for the period 1969 to 1980 for the variable GNP at market prices (GNPM), total consumption (TC), total fixed investment (TFI), inventory investment (II), total exports of goods and services (X), total imports of goods and services (M), the GNPM deflator (PGNPM) and the consumer price index (CPI) and are presented in the Tables 12, 14 and 16 (Appendix 3), while in the Tables 13, 15 and 17 (Appendix 3) the cumulative effect of the multipliers on GNPM, TC, TFI, II, X and M for each period up to 1980 is given.

As it can be seen from these tables and the graphs following them all the three simulations produce cyclical but damped movements in these endogenous variables.

The increase in government expenditure (GCE) had the largest impact on GNPM compared with the other two simulations concerning changes in the exchange rate (ER) and changes in the discount rate (DIRA).

The increase of 1 billion drs in GCE produced initially an impact multiplier of 8.7 for GNPM, while the cumulative effect after 12 years was 5.8.

The normalised step increase in 1969 in the exchange rate, resulted in a decrease of GNPM of 3.35 in the first period and the total effect in 1980 was a decrease of 2.2.

The impact multiplier of GNPM after the step increase in DIRA in 1969 was 4.9 and the cumulative effect after 12 years in 1980, was 2.4[50].

The initial positive (negative) multipliers for almost all variables in the three simulations, are followed by large negative (positive) multipliers in the next period, before the cycles start damping down.

These increases in GNPM, especially the one resulted from the step increase in GCE, may seem rather large. But government expenditure changes may exercise a larger influence in economies of this structure and stage of development. On the other hand the multipliers calculated from the reduced form of the system generally have very different properties from those calculated from the structural reactions[51].

As it can be seen from Tables 12, 13 (Appendix 3) the initial impact of the GCE increase by 1 billion drs has mainly led to the increase in stocks (multiplier 3.8) and total consumption (multiplier 2.99). The initial increase in total fixed investment and total exports was smaller (multipliers 1.3 for both) while there was a considerable increase in imports (multiplier 2). However the increase in GCE also led to increases in prices, as the GNPM deflator increased by 2.9 and CPI by 2 points (base year 1970:100) in the first period, and while PGNPM approached the magnitude it had without the

GCE increase (control solution) the CPI increased for the next period as well (multiplier 1.2). The particular deflators for the GNP components showed also an increase in the first period. The consumption categories deflators increased in 1969 by 2 to 3 points but the following year they approached the magnitude of the control solution. The deflators for CI and HI followed the same patterns of movements as that of consumption deflators, but the one for EI showed a small increase in the initial period and then decreased by 4 points in 1970 and by 1.5 in 1971 before approaching the control solution the next year. The inventory deflator decreased sharply relative to the control solution in 1969 (from 126 to 109) and then increased significantly in 1970 (from 93 to 104) while for the next two years was lower than the control solution which was approached in 1973. Import and export prices increased significantly in the first year (especially the export of services price) but in the next year or in 1971 the control solution was approached.

This increase in almost all price deflators for one or two periods was shown as a slack in the economic activity and hence in negative multipliers for the second period in the simulation. The exception was total fixed investment which showed a modest increase in the next two years, helped by the decrease in the price of equipment investment and the increase in loans (which is an explanatory variable in the investment functions).

Loans increased relatively to the control solution by 2 to 3 billion drs each period from 1969 to 1975. Currency in circulation (CUR) increased in the first period only while deposits showed almost no difference from the control values over all the periods in the simulation.

From the third period most multipliers have small magnitudes (positive or negative) and the cyclical pattern after two or three years damps down as the cumulative values of the multipliers also indicate in Table 13 (Appendix 3).

The simulation, with a step increase in drachmae per U.S. dollar (10% devaluation), showed that the multipliers (after normalization) follow the opposite pattern from those of the increase in GCE (Tables 14, 15, Appendix 3).

The devaluation resulted in a negative impact multiplier in the initial period for GNPM (-3.3). Also for all the components of GNPM, except exports, the impact multipliers are negative (total consumption -1.2, inventory investment -1.6). The import prices were increased (PMG from 101 to 111 in 1969) and imports were decreased (the import multiplier was -1.75). Since investment and especially equipment investment depend on imports, the simulation showed that the strongest impact of devaluation was on investment (multiplier -2.6). At the same time the export prices were decreased (PXG moved from 92 to 87 in 1969) and exports were modestly increased (multiplier 0.9).

The impact multipliers for PGNPM and CPI were very small (0.10 and -0.15 respectively). But in the next two years the multipliers for the former were 2.01 and 1.01 points and for the latter 1.33 and 1.18. The consumption deflators in the first period showed a small increase between 0.5 to 2 points, while for the next two years they increased between 4 and 6 points in 1970 and 2 to 3 points in 1971 relative to control solution. In 1972 and 1973 they decreased by about 2 points for each year before approaching the control solution.

The deflators for construction and housing investment decreased relative to control solution by 9 and 4 points respectively in the first period, while the deflator for equipment investment (heavily dependent on imports) increased by 9 points. The CI and HI deflators for each of the two subsequent years increased by 4 to 5 points, they became lower in 1972-1973 by 2 points and then approached the control solution. The deflator of equipment investment had a different pattern of time response. The second period decreased by 4 points, then increased first by 8 points and in 1972 by 2 points. This pattern was followed by a 2 point decrease for each of the following periods (1973-1974), before the control solution approximated. The deflator for inventory investment increased the first two periods (5 points the first and 40 points in the second) and decreased the next two periods (7 points in 1971 and 2 in 1972) and then had the control values[52].

The price changes effect appears with a lag and does not follow the same time path for all deflators. Thus, as some deflators have shown in the first period a decrease (either a small one as the CPI or a substantial one as those of CI and HI investment) and because of this lagged effect, a rise in consumption and investment took place in the second period (multiplier for consumption 0.35 and for investment 0.61) while a larger increase resulted in inventories (multiplier 1.7). As the price of exports increased in the second period exports were decreased (multiplier -0.76). But the lagged effect of the increase in prices, mentioned above, resulted in a decrease in the economic activity in the third period (GNPM multiplier -0.39).

Because of the lag, the effect of two successive years of rises in almost all price deflators caused a slack in economic activity in the fourth period. The slack was not as severe as in the first period when the exchange rate was given a step increase. Thus in 1972 the multiplier for GNPM was -1.5. The multipliers of GNPM for the next two years were positive (0.58 and 0.78) as the effect of the decreases in prices affected the economy.

In the remaining periods in the simulation, the multipliers decreased and damped down, as the cumulative values in Table 15 also suggest.

Compared with the simulation for GCE, the exchange rate simulation decreased the GNPM and its components (except exports), but the magnitude of its cumulative effect is smaller than that of the GCE step increase.

At the same time the exchange rate revealed a stronger cyclical effect on the endogenous variables which lasted longer before damped down.

Another feature of the exchange rate simulation was its larger effect on the financial variables compared with the effect of the government expenditure simulation. In the case of exchange rate, CUR decreased by 3.2 billion drs in the first period following the decline in economic activity. In the next two years, as prices increased, currency increased by 4.5 billion and 3 billion drs respectively, while in the fourth and fifth period CUR decreased by 1.3 billion and 1.4 billion drs tracing the downward movement in prices.

On the other hand the diverse and cyclical movement in prices was followed by a persistent increase in loans and deposits for most of the periods in the simulation. Loans increased in the first period by 0.9 billion drs and in the next six periods by an amount between 7.5 and 9 billion drs each year; deposits were increased in the first seven periods of the simulation by 9 to 10 billion drs each year.

The DIRA simulation had impact multipliers of significant magnitude, as it is shown in Table 16 (Appendix 3). The simulation has also resulted in increasing the consumption and exports deflators (in the first period only) and those of investment (for the first two periods). At the same time the deflator for inventories showed a large increase in the first period relative to control solution (from 109 to 128) but also a large decrease in the second one (from 103 to 79) followed by a small increase in 1971 (from 91 to 97). The PGNM multiplier was in the first period 2.7, while CPI was affected for the first two periods (multipliers 1.49 and 1.54).

The result was a negative multiplier for GNPM and its component (except for exports) as Table 16 (Appendix 13) indicates.

The multipliers then follow a cyclical pattern and damped down rapidly.

The effect of DIRA simulation on the financial variables follows almost exactly the same pattern as that of the government expenditure simulation, concerning the magnitude and the path of the changes it produces as money, deposits and loans. (It has only a stronger increasing effect on the interest rate for deposits in the first period.)

The cumulative effect of the discount rate simulation was not large, and especially for total fixed investment and changes in stocks this effect is 0.6 for the former and -0.04 for the latter, while for exports it does not exceed 0.5.

By far the strongest influence on GNPM and its components was exercised by the increase in government expenditure on goods and services, as the figures in Tables 13, 15 and 17 indicate. For example after 12 periods in the simulation (1980) the cumulative effect on GNPM of the increase in GCE is 5.8, of exchange rate -2.2 and of DIRA 2.4.

10.9 Conclusions

The main aim of this work was to construct a forcasting model and to test, in a dynamic forecast context, its response to the rapid and critical changes in the conditions in which the economy operated in the years 1978-1982. An important aspect of a system describing an economy of a particular period of time, is to examine the effects that changes of economic magnitudes have on the rest of the economy.

Thus the method of factor analysis was used in the reduced form to account for these effects in a parsimonious way because of the relatively large number of variables involved. Both the orthogonal and oblique rotation of the factors were attempted and their forecasting power was tested.

The various sectors of the economy were separately examined in an effort to find out the particular structural relationship that better describes the specific economic magnitudes. In this way some hypotheses were tested and some changes were made to examine the effects of other variables as well.

The research into the various aspects of each economic relationship was neither detailed nor exhaustive, as the purpose of this study was not to test the various competing hypotheses.

The main subsectors, such as consumption, investment, imports-exports and wage-prices, were examined mainly in the broad context of the mainstream and generally held theories. Consumption is examined in the light of permanent (expected) income hypothesis, investment is based on the stock adjustment principle, while prices follow the mark up form of analysis. Import and export functions were determined essentially by demand and supply conditions. The demand for money depends on transactions, while the remaining relationships of the financial sector are based on simple equilibrium supply and demand models.

From a forecasting point of view most individual equations predict quite satisfactorily outside the sample period for two, three or four years ahead (depending on the availability of data), as it was explained in some detail in the previous chapters. But for others, for example housing investment and some equations in the price sector, their forecasting inadequacy is obvious; they were retained in the model however, as no better relationship was possible to be established, despite all efforts made.

The model built is of the Keynesian type. Its purpose was to determine the demand-expenditure side of the economy; it has not been attempted to answer technical feasibility problems or the motivation behaviour of the economic agents.

Some of the estimated relationships in this study were examined in the framework of simple models. A number of attempts were made to use more sophisticated models or statistical procedures to determine the structural relationships, but this gave unsatisfactory results. Whether a number of lagged endogenous and explanatory variables were employed (in order to determine the appropriate lag as in price equation) or a correction error mechanism was introduced (consumption) and whether the seemingly unrelated variables procedure (consumption, investment) or the nonlinear least squares (investment-prices) or the Box-Jenkins method (in forecasting exogenous variables) were tried, the results were unsatisfactory.

Due to the shortage of the degrees of freedom and the problem of multicollinearity all these attempts produced coefficients with implausible magnitudes, statistically insignificant, with signs contrary to those expected or suggested by economic theory, while the implied mean lags were sometimes incredibly long.

In the dynamic forecasts generated by the model, its version with both orthogonal and oblique factors gave sensible results but the latter was found to accumulate the forecast error as time passes and thus the version with orthogonal factors was preferred.

The model is sensitive to changes in prices and although individually many of the price equations forecast satisfactorily, they failed to track down closely the actual prices for the last years in the sample in a dynamic simulation context. This discrepancy deteriorated further in the forecasts generated outside the sample and had serious repercussions for the predictive power of the model as it has already been explained in detail[(53)].

Inventory investment was the other function which completely failed to track down the actual changes in stocks in the dynamic forecasts for 1978-1982 and influenced the forecast error for GNPM.

Although models are only approximations of the economy as it existed at the time they were estimated[(54)] and no adjustments were made to account for the various significant and sudden changes that the economy went through all these turbulent years (1978-1982), the dynamic forecasts of the model for this period are quite satisfactory for many of the GNP components, as it has already been indicated.

It has been rightly remarked that "each econometric study is another piece of information about a complex subject rather than the definite estimate of some true model... and that the accumulating and sifting econometric information will permit specialists to make better and more informed judgements"[(55)].

It is hoped that this work is just a small contribution to the accumulation of this information.

FOOTNOTES TO CHAPTER TEN

1. K.F. Wallis "Some Recent Developments in Applied Econometrics: Dynamic Models and Simultaneous Equation Systems", Journal of Economic Literature 7/1969, p.786n.

2. H. Theil and J.C.G. Boot, The Final Form of Econometric Equation Systems, in Readings in Economics, Statistics and Econometrics, A Zellner ed., 1968.

3. G. Fromm, "An Evaluation of Monetary Policy Instruments" in The Brookings Model: Some Further Results, J.S. Duesenberry, G. Fromm, L.R. Klein, E. Kuh eds., 1969.

4. F.M. Fisher, "Dynamic Structure and Estimation in Economy-Wide Econometric Models" in The Brookings Quarterly Econometric Model of the United States, J.S. Duesenberry, G. Fromm, L.R. Klein, E. Kuh eds., 1965.

5. Fisher, op. cit.

6. More sophisticated simulations can be performed by specifying also a joint probability distribution for the estimated coefficients of each equation: P.S. Pindyck and D.L. Rubinfeld, Econometric Models and Economic Forecasts 1981.

7. H. Theil (1961) introduced the U statistic; cited in Pindyck and Rubinfeld, op. cit.

8. Pindyck and Rubinfeld, op. cit.

9. For details of the test, its implementation and importance see A.C. Harvey, The Econometric Analysis of Times Series, 1981, pp 336-339.

10. Fisher, op. cit.

11. T. Kloek and L.B.M. Mennes, "Simultaneous Equation Estimation Based on Principal Components of Predetermined Variables", Econometrica 28(1960).

12. Bridger M. Mitchell, "Estimation of Large Econometric Models by Principal Components and Instrumental Variable Methods", The Review of Economics and Statistics, 53 (1971).

13. Mitchell, op. cit.

14. M.D. McCarthy, "Notes on the Selection of Instruments for Two Stage Least Squares and K Class Type Estimators of Large Models", University of Pennsylvania Department of Economics, Revised Discussion Paper No. 125.

15. Mitchell, op. cit.

16. M.H. Salmon and J.R. Eaton "Estimation Problems in Large Econometric Models: An Application of Various Estimation Techniques to the London Business School Model", in G.A. Renton (ed.) Modelling the Economy, 1975, pp 323-348.

17. For withholding some variables in principal components analysis, see G.B. Pidot, "A Principal Components Analysis of the Determinants of Local Government Fiscal Patterns", Review of Economics and Statistics, 51(1969).

18. For the effects of using principal components on multicollinearity, see B.T. McCallum, "Artificial Orthogonalization in Regression Analysis", Review of Economics and Statistics, 52 (1970).

19. Weisberg S., Applied Linear Regression, 1980, pp 170-172.

20. A characteristic root less than one does not help to increase the common variance components h_i^2 (i= 1,2...,n) of the variables belonging to the vector associated with this characteristic root: J.H.F. Schilderinck, Regression and Factor Analysis in Econometrics, 1977, p.96

21. McCarthy, op. cit.

22. The terms factors and principal components are here used interchangeably and no difference between them is implied. In Chapter 2 a detailed exposition of factor analysis has been given and conceptual differences between the factor and the principal component models have been mentioned.

23. It should be mentioned that the lagged reciprocal of the unemployment variables was included in the wage equation when the various reduced form models, stated above, were estimated. In the finally preferred reduced form model and the structural equation the current period reciprocal of the unemployment, which gave better results was included.

24. The purpose of this exercise was not to validate the model, that is to substantiate that it is the best representation of the structure of the economy. In that case no additional information other than that in the reduced form could have been obtained from simulations within the sample. The purpose of testing by dynamic simulating various versions was to find the one which would generate better forecasts: R.C. Fair, A Short Run Forecasting Model of the U.S.A. Economy, 1971, pp. 124-125.

25. M. Desai in a different context has suggested that an estimating method should be chosen on the basis of minimizing forecasting errors rather than on the basis of the classical properties of different estimators: G.A. Renton, Modelling the Economy, 1975, p.349.

26. The predetermined variables in each set of variables used in the simultaneous and the block recursive systems to calculate principal components, are mentioned in Appendix 2.

27. H.H. Harman, Modern Factor Analysis, 1976. The more sophisticated methods of estimating the factors by Maximum Likelihood and Least Squares methods, proposed by K.G. Jöreskog, were also tried, but unsuccessfully, because the correlation matrix of the variables subjected to factor analysis was ill-conditioned.

28. As mentioned in chapter 2, for oblique rotation in factor analysis.

29. It should be mentioned that the two sets of variables were combined to one set and principal components were calculated from the 39 variables included in this combined set. There were no essential differences concerning the number of factors with loadings of considerable magnitude, the cluster of variables on the various factors and the cumulative percentage of variance accounted for by them.

30. For both the first and the second set of variables more than four factors were included in the orthogonal and oblique rotation. But the loadings in the remaining components (beyond the fourth) were small in magnitude and a meaningful interpretation could not be attached to them.

31. In chapter 2 (factor analysis).

32. The disturbance term Vi in the reduced form equations must also satisfy the assumption concerning the error term in the structural equations: A. Koutsoyiannis, Theory of Econometrics, 1977. The Hildreth-Lu procedure was described in Chapter 2, in the section for autocorrelation.

33. The identities included in the system are mentioned in Appendix 3.

34. P. Ormerod, "Manufactured Export Prices in the United Kingdom and the Law of One Price", Manchester School, 47-48 (1979-1980).

35. A.L. Nagar, "Stochastic Simulation of the Brookings Econometric Model", in The Brookings Model: Some Further Results, op. cit.

36. The list of variables for which the RMSPE was calculated are mentioned in Appendix 3.

37. In the first set of variables of the first block of the recursive system only four predetermined variables were included. Hence the reduced form equations of the first block were also estimated by using these variables directly instead of the two principal components as described in the corresponding section. (For the variables in the second set, the two factors which were calculated from them, were included in both forms of rotation.) The results of the simulations performed were inferior to those presented in Table 1, Appendix 3 and subsequently no further use of these models was made.

38. The construction of these composite variables has been analysed in the chapter of International Transactions.

39. The brief exposition of the main elements of ARIMA models is mainly based on G.E.P. Box and G.M. Jenkins, Time Series Analysis Forecasting and Control, 1976.

40. Box and Jenkins, op. cit.

41. The computations were carried out by using the statistical programme MINITAB. For most of the computations in this work the statistical programmes TSP and SPSS were also extensively employed.

42. Nagar, op. cit., pp 443-444.

43. Pindyck and Rubinfeld, op. cit.

44. G. Fromm and L.R. Klein, "The NBER/NSF Model Comparison Seminar: an Analysis of Results", Annals of Economic and Social Measurement, 5/1 (1976), p.5. Also C.F. Christ, "Judging the Performance of Econometric Models of the U.S. Economy", International Economic Review, 16/1 (1975), p.64.

45. Fromm and Klein, op. cit., pp. 4-6.

46. Fromm and Klein, op. cit.; S.H. Haymans and H.T. Shapiro, "The Structural Properties of the Michigan Quarterly Econometric Model of the U.S. Economy", International Economic Review, 15/3(1974).

47. E.P. Howrey, L.R. Klein and M.D. McCarthy, "Notes on Testing the Predictive Performance of Econometric Models", International Economic Review, 15/2(1974); Christ, op. cit.

48. Christ, op. cit.

49. Tax multipliers were also calculated but were very small compared with those of GCE. Although tax multipliers are smaller than those of government expenditure (Christ, op. cit) their differenceswere in this case very substantial. This could be attributed to the structure of the model; no lagged tax variables were included in the equations, but only the lagged rate of indirect taxes which had a small and insignificant effect on the CPI and PGNPM (in the reduced form equations the effect of the lagged rate of indirect taxes was

exercised through its inclusion in the principal components). Thus no balance budget multipliers were calculated.

50. Although economic theory maintains that an increase in the interest rates would depress the economic activity, the simulations with DIRA resulted in an increase of GNP and economic activity in general in the first period (the cumulative effect was also positive). But no immediate satisfactory explanation of these results could be found.

51. Fromm and Klein, op. cit.

52. The 40 points increase of this deflator is too large to be justified; it is probably connected with problems of data. Moreover the inventory investment equations does not perform satisfactorily and, as component of GNP aggravates considerably its forecasting error.

53. An attempt was made to correct the price equations, estimating them by weighting regression. The fitted value of prices deviated substantially from the actual ones in the last years of the sample and the residual errors were increased. It was thus assumed that the error term in the price equations was heteroskedastic and influenced by the price of world exports, PWXG; that is, the strong inflationary pressures of the mid-70's were mainly attributed to the effects of the international environment. Hence the reduced form price equations were re-estimated by weighted least squares, corrected for first order autocorrelation with weight the variable PWXG, and forecasts were then generated. But there was virtually no improvement.

54. Christ, op. cit.

55. M. Feldstein, "Inflation, Tax Rules and Investment: Some Econometric Evidence", Econometrica, 50/4 (1982).

APPENDIX 1

TABLE 3.1 CONSUMPTION EXPENDITURE AND GROSS NATIONAL PRODUCT 1954-1977 (CONSTANT 1970 PRICES) BILLION DRS

	1954	1959	1964	1969	1973	1977
National Consumption Expenditure	81.9	103.8	137.5	190.7	249.5	295.4
a. Consumption of non-durables	49.8	59.5	73.6	99.1	122.0	135.7
b. Consumption of durables (including semi-durables)	8.6	14.5	23.8	34.5	57.0	76.3
c. Consumption of services	24.3	31.2	41.5	59.7	80.3	95.5
Gross National Product at Market Prices	102.8	139.0	196.6	282.2	378.9	431.2
			Percentages			
Consumption of non-durables/ Total domestic consumption	60.21	56.51	52.94	51.29	47.05	44.13
(Food and beverages expenditure/ Consumption of non-durables)	(83.17)	(83.14)	(82.19)	(78.50)	(74.32)	(73.74)
(Clothing and footwear/semi durables)	-	(77.74)	(77.88)	(77.06)	(78.59)	(76.10)
Consumption of durables*/ Total domestic consumption	10.41	13.82	17.16	17.84	22.00	24.81
(Consumption of durables/ Consumption of durables and semi durables)	(23.08)	(24.10)	(22.85)	(24.56)	(28.03)	(36.96)
Consumption of services/ Total domestic consumption	29.38	29.67	29.90	30.88	30.95	31.06

Continued...

Table 3.1 Continued

	1954	1959	1964	1969	1973	1977
			Percentages			
(Rent Gross and water charges/ Consumption of services)	(42.93)	(41.39)	(39.50)	(38.12)	(38.71)	(39.20)
National Consumption expenditure/ GNP (at market prices)	79.76	74.68	69.93	67.60	65.84	68.50

* Including semi-durables

TABLE 3.2 DISPOSABLE INCOME AND SAVINGS 1954-1977 BILLION DRS.

	1954	1959	1964	1969	1973	1977
Personal disposable income at current prices	53.0	82.4	131.5	214.6	399.2	775.8
National consumption expenditure at current prices	52.1	79.4	116.3	184.9	304.6	638.1
Savings† at current prices	0.9	3.0	15.2	29.7	94.6	137.7
Personal disposable income at constant 1970 prices	72.7	103.0	152.9	225.9	321.9	340.3
Savings at constant 1970 prices	1.3	3.8	17.7	31.3	76.3	60.4
			Percentages			
Savings/Personal disposable income*	1.77	3.68	11.58	13.86	23.67	17.76
Real liquid assets/Real disposable income	16.06	27.23	42.86	54.07	60.07	70.57
$APC = \frac{\text{National consumption expenditure}}{\text{Real disposable income}}$ (deflated by the implicit deflator of total consumption)	98.4	96.6	88.6	86.1	76.6	82.7

* (Both are deflated with the consumer price index base 1970:100).

† Savings are calculated as the difference between personal disposable income and total national consumption expenditure.

TABLE 3.3 ANNUAL GROWTH RATES (PERCENTAGES) OF VARIABLES IN TABLES 3.1 AND 3.2

	1954-58	1959-63	1964-68	1969-73	1974-77
GNP at market prices	5.47	5.48	5.53	6.07	3.95
National consumption expenditure	4.25	3.93	5.36	5.51	4.14
a. Consumption of non-durables	3.08	3.72	4.97	4.24	2.71
b. Consumption of durables (including semi-durables)	11.02	6.98	6.19	10.60	8.51
c. Consumption of services	4.09	4.28	5.98	6.11	4.32
Personal disposable income at constant 1970 prices	5.40	6.09	5.71	7.34	3.70
Savings at constant 1970 prices (Both deflated with the consumer price index)	28.50	33.39	7.17	19.49	2.57
Breaking the above growth rate of consumption of durables into its constituent parts of durables and semi-durables(a)					
b1 Durables	10.38	6.43	7.32	13.56	17.62
b2 Semi-durables	11.21	7.15	5.85	9.56	4.53

(a) The figures for the three consumption categories for the period 1954-1958 are not as accurate as those for subsequent years.

BLE 3.4 IMPLICIT PRICE DEFLATORS, CONSUMER PRICE INDEX, RELATIVE PRICES AND THEIR RATE OF CHANGE BASE YEAR 1970:100

	1954	1959	1964	1969	1973	1977
Consumer price index (CPI)	73.0	80.0	86.0	95.0	124.0	228.0
Implicit deflators of						
Non-durables (PCND)	63.0	75.0	84.0	98.0	128.0	230.0
Durables and semi-durables (PCD)	72.0	86.0	87.0	97.0	119.0	205.0
Services (PCS)	62.0	75.0	84.0	96.0	117.0	208.0
Relative prices of						
PCND/CPI	86.3	94.0	97.9	102.7	103.4	101.1
PCD/CPI	98.6	107.0	101.5	102.4	96.3	89.9
PCS/CPI	85.3	93.6	98.0	100.7	93.9	91.1

Annual Rate of Change (Percentages)

	1954-58	1959-63	1964-68	1969-73	1974-77
CPI	2.85	1.22	2.01	5.47	9.60
Implicit deflators of					
PCND	3.24	1.72	2.31	5.61	9.68
PCD	2.71	0.16	1.92	4.18	8.82
PCS	3.36	2.03	1.92	4.01	9.74

Continued

Table 3.4 Continued

	1954-58	1959-63	1964-68	1969-73	1974-77
Relative prices of					
PCND/CPI	0.39	0.52	0.30	0.13	0.07
PCD/CPI	-0.13	-1.04	-0.09	-1.23	-0.71
PCS/CPI	0.51	0.80	-0.09	-1.39	0.12

TABLE 3.5 POPULATION STATISTICS (IN THOUSANDS)

Age Groups	Censuses 1951	Censuses 1961	Censuses 1971	Percentage in Total 1951	Percentage in Total 1961	Percentage in Total 1971
0- 9 years	1422	1511	1499	18.6	18.1	17.1
10-19 "	1563	1356	1391	20.5	16.2	15.9
20-29 "	1337	1446	1140	17.5	17.2	13.0
30-39 "	1007	1233	1252	13.2	14.7	14.3
40-49 "	910	956	1169	11.9	11.4	13.3
50-59 "	620	864	920	8.1	10.3	10.5
60-69 "	449	567	798	5.9	6.7	9.1
70-Over "	325	456	600	4.3	5.4	6.8
Total	7633	8389	8769	100.0	100.0	100.0

Censuses	Population in Thousands				Percentage			
	Total	Urban	Semi-(a) Urban	Rural	Urban	Semi-Urban	Rural	Total
1951 Census	7633	2880	1130	3623	37.7	14.8	47.5	100.0
1961 "	8389	3628	1086	3675	43.3	12.9	43.8	100.0
1971 "	8769	4667	1019	3082	53.2	11.6	35.2	100.0

TABLE 3.6 EMMIGRATION*

1954-1958	146
1959-1963	315
1964-1968	404
1969-1973	318
1974-1977	86

* The above figures of emmigration are in thousands and refer to permanent emmigration (over one year).

Source: Statistical Yearbook of Greece, 1980

(a) urban: settlements over 10,000 inhabitants

semi-urban: settlements over 2,001-9,999 inhabitants

rural: below 2,000 inhabitants.

TABLE 3.7 EXPENDITURE ON PERSONAL TRANSPORT EQUIPMENT 1959-1977 AT CONSTANT 1970 MILLION DRS

Years	Expenditure on Personal Transport Equipment	Ratio of Expenditure on Personal Transport Equipment over Expenditure on Durables[a] %
1964	0.5	9.10
1969	0.8	9.47
1973	2.1	13.02
1977	9.4	33.25

Periods	Growth Rate of Expenditure on Personal Transport Equipment %
1964-68	9.31
1969-73	21.02
1974-77	46.91

Source: National accounts of Greece.

(a) Consumption expenditure of semi-durables is excluded.

TABLE 3.8 ANNUAL RATE OF CHANGE FOR THE SAMPLE PERIOD 1954-1977 (UNLESS OTHERWISE STATED)

		%
Total private domestic consumption expenditure at constant 1970	prices, billion drs	5.62
Total national consumption expenditure	"	5.49
Consumption of non-durables	"	4.26
Consumption of durables (including semi-durables)	"	9.51
Consumption of services	"	5.87
Gross national product at market prices	"	6.16
Disposable income (deflated by consumer price index)	"	6.64
Savings (deflated by consumer price index from 1956)	"	10.35
Consumer price index		4.86
Implicit deflator for consumption of non-durables		5.55
Implicit deflator for consumption of durables and semi-durables		4.46
Implicit deflator for consumption of services		5.15
Relative prices for non-durables[a]		0.66
Relative prices for durables and semi-durables[a]		-0.38
Relative prices for services[a]		0.28
Population change in thousands mid-year estimate		0.67
The separate figures for consumption of durables broken into:		
Durables		11.69
Semi-durables		8.61

Source: National accounts of Greece.

(a) They were calculated dividing the corresponding implicit deflators by the consumper price index.

TABLE 5.1 TOTAL GROSS FIXED INVESTMENT EXPENDITURE, INVESTMENT BY TYPE AND SECTOR AND GNP 1954-1977*

	1954	1959	1964	1969	1973	1977
Total fixed investment	14.4	25.3	43.4	71.7	100.1	85.9
	(3.7)	(7.6)	(11.0)	(19.2)	(29.1)	(21.3)
GNP at market prices	102.8	139.0	196.6	282.2	378.9	431.2
By type						
Housing Investment	6.1	7.9	13.7	23.2	30.6	26.4
Construction Investment	4.7	10.5	17.2	25.5	34.4	28.1
Equipment Investment	3.6	6.9	12.5	23.0	35.1	31.4
By sector						
Agriculture	1.2	3.8	5.7	7.5	9.7	8.3
	(0.5)	(1.4)	(2.3)	(2.9)	(4.0)	(2.6)
Manufacturing	1.8	3.1	5.6	8.4	14.4	12.6
Electricity, gas, etc.	1.6	2.6	3.9	6.9	8.7	5.7
	(1.4)	(2.3)	(3.7)	(6.7)	(8.4)	(5.3)
Transportation and Communication	1.2	3.8	8.0	14.2	20.6	16.7
	(0.7)	(2.6)	(4.8)	(7.6)	(10.4)	(6.4)
Other service industries	1.9	3.6	5.8	9.7	13.4	14.1
	(0.5)	(0.8)	(0.8)	(1.2)	(3.2)	(3.2)

*The above figures are billion drs at constant 1970 prices.

Figures in brackets show government investment expenditures.

TABLE 5.2 GROWTH RATES OF TOTAL GROSS FIXED INVESTMENT, INVESTMENT BY TYPE AND SECTOR AND GNP

	1954-1958	1959-1963	1964-1968	1969-1973	1974-1977
Total fixed investment	10.93	7.34	6.81	6.91	3.64
GNP at market prices	5.47	5.48	5.52	6.07	3.95
By Type					
Housing investment	6.50	7.51	7.24	5.67	13.60
Construction investment	12.19	7.90	6.07	6.20	0.57
Equipment investment	15.69	6.25	7.34	8.86	0.21
By Sector					
Agriculture	21.76	5.95	4.47	5.41	4.30
Manufacturing	14.29	7.34	5.18	11.40	-4.13
Electricity, gas, etc.	3.81	0.86	7.18	5.05	-8.59
Transportation and communication	26.41	10.39	7.68	7.72	2.53
Other service industries	7.23	8.61	7.70	6.65	5.68

TABLE 5.3 SHARE OF INVESTMENT CATEGORIES TO TOTAL INVESTMENT IN PERCENTAGES

	1954	1959	1964	1969	1973	1977
By Type						
HI/TFI	42.36	31.10	31.56	32.39	30.55	30.75
CI/TFI	32.32	41.45	39.71	35.52	34.34	32.68
EI/TFI	25.32	27.45	28.73	32.09	35.11	36.57
By Sector						
Agriculture/TFI	8.77	15.22	13.09	10.39	9.68	9.66
Manufacture/TFI	12.38	12.20	12.95	11.76	14.44	14.66
Electricity, gas, etc/TFI	10.96	10.34	8.95	9.53	8.73	6.64
Transportation and communication/TFI	8.24	14.94	18.36	19.79	20.55	19.47
Other service industries/TFI	13.21	14.40	13.37	13.56	13.40	16.44
TFI/GNP at market prices	14.00	18.17	22.10	25.39	26.42	19.93

HI = Housing Investment, CI = Construction Investment, EI = Equipment Investment and TFI = Total Fixed Investment.

TABLE 5.4 IMPLICIT INVESTMENT DEFLATORS

Implicit Deflators	1954	1959	1964	1969	1973	1977
PHI	56.0	68.0	74.0	91.0	136.0	262.0
PCI	55.0	65.0	70.0	90.0	133.0	258.0
PEI	65.0	52.0	88.0	95.0	138.0	254.0

RATE OF CHANGE (%)

Implicit Deflators	1954-58	1959-63	1964-68	1969-73	1974-77
PHI	3.83	1.47	3.53	8.40	10.59
PCI	3.16	1.20	4.45	8.20	10.76
PEI	0.18	4.07	1.71	7.77	11.79

PHI = the implicit deflator of housing investment, PCI = the implicit deflator of construction investment and PEI = the implicit deflator of equipment investment.

TABLE 5.5 GOVERNMENT INVESTMENT

	1970	1973	1977
Total Government fixed investment	19.9	29.1	21.3
By Type			
Government housing investment	0.3	0.3	0.3
Government construction investment	16.3	20.9	15.6
Government equipment investment	3.3	6.6	3.3
In percentages			
Government housing investment/HI	1.50	1.14	1.01
Government construction investment/CI	63.25	60.88	55.61
Government equipment investment/EI	13.28	18.86	10.54

GROWTH RATE OF GOVERNMENT INVESTMENT

	1970-1973	1974-1977
Total government fixed investment	9.94	-2.94
By Type		
Government housing investment	4.04	8.98
Government construction investment	6.47	0.08
Government equipment investment	18.66	-15.59

HI = housing investment, CI = construction investment, EI = equipment investment. (Disaggregated data of government investment by type are given in the national accounts from 1970.)

TABLE 7.1 EXPORTS AND IMPORTS (IN MILLION DRS AT 1970 PRICES)

	1954	1959	1964	1969	1973	1977
Total Exports of Goods (FOB)	5360	6963	9256	17123	32433	43331
Export of services	732	1720	2037	3587	5440	5027
Expenditure of non-residents	1234	2155	3494	5980	12974	14131
Total	7326	10838	14787	26690	50847	62489
Total imports of goods CIF	9915	14773	27024	43903	72280	74403
Imports of services	279	1040	2800	4476	14386	13428
Expenditure of residents abroad	474	859	1637	3424	3693	3814
Total	10668	16672	31461	51803	90359	91465
GNP at market prices	102756	139044	196586	282168	378904	431164
Percentages						
Exports of goods/GNP	5.22	5.01	4.71	6.07	8.56	10.05
Total exports/GNP	7.13	7.79	7.52	9.46	13.42	14.49
Total imports/GNP	10.38	11.99	16.00	18.36	23.85	21.26
Total exports/Total imports	68.67	65.01	53.28	51.52	56.27	68.19

TABLE 7.2 BALANCE OF INTERNATIONAL TRANSACTIONS (IN MILLION DRS)*

Balance of goods and services	-4229	-6080	-15544	-23895	-83191	-88334
Balance of goods, services and incomes	-3356	-4544	-12194	-18863	-40106	-58055
Balance after net transfers have been included	-1950	-1672	-6831	-10679	-18477	-25778

* at current prices

TABLE 7.3 SHARE OF EXPORT-IMPORT CATEGORIES TO TOTAL EXPORTS-IMPORTS

	1954	1959	1964	1969	1973	1977
Exports of primary products (SITC 0-4)[a]	90.12	92.92	88.62	63.70	57.97	45.47
Exports of manufactured (SITC 5-9)	9.88	7.08	11.38	36.30	42.03	54.53
Imports of primary products (SITC 0-4)[a]	45.76	37.59	33.00	32.94	35.56	37.62
Imports of manufactured (SITC 5-9)	54.24	62.41	67.00	67.06	64.44	62.38
Rates of growth[b]	1954-58	1959-63	1964-68	1969-73	1974-77	1954-77
Exports of goods	6.21	4.35	9.34	13.63	5.94	9.10
Total exports	7.33	6.06	9.51	13.76	6.73	9.34
Imports of goods	10.65	10.42	7.48	10.49	3.23	8.76
Total imports	11.28	10.36	7.35	11.77	5.09	9.37

a. The share of export categories to total exports, and import categories to total imports have been calculated from the corresponding figures in value terms.

b. The rates of growth have been calculated from figures in real terms (1970) prices.

TABLE 8.1 PRODUCTIVITY[a]

	PROD	PROD 3 years moving average	PROD 5 years moving average	DOT PROD %	DOT PROD from 3 years moving av. %	DOT PROD from 5 years moving av. %
1954	69	-	-	-	-	-
55	72	73	-	4.35	-	-
56	79	77	77	9.72	5.10	-
57	80	81	80	1.23	5.32	4.30
58	84	83	84	5.00	2.47	4.60
59	85	86	87	1.19	4.02	3.72
1960	90	90	90	5.88	4.21	3.74
61	95	94	93	5.56	4.16	3.57
62	96	97	98	1.05	3.59	5.53
63	100	102	104	4.17	5.41	5.44
64	111	109	109	11.00	6.86	5.18
65	117	117	115	5.41	6.84	5.79
66	122	122	123	4.27	4.59	6.53
67	127	129	130	4.10	5.41	5.64
68	137	137	137	7.87	6.18	5.52
69	146	145	145	6.57	6.41	5.84
1970	153	154	154	4.79	5.75	6.38
71	162	163	164	5.88	5.82	6.08
72	173	173	169	6.79	6.34	3.79
73	184	177	175	6.36	2.75	3.29
74	175	179	179	-4.89	1.25	2.89
75	179	180	183	2.29	0.44	1.96
76	186	185	-	3.91	2.78	-
77	190	-	-	2.15	-	-

a. Productivity (PROD) is expressed in thousand drs. - constant 1970 prices. DOT PROD is the annual rate of change of productivity.

APPENDIX 2

Predetermined Variables on which Principal Components were Calculated:

The total number of lagged endogenous, exogenous and lagged exogenous variables involved was 39. These variables were split into two sets of 26 and 13 variables respectively. The first group contained expenditure, income and monetary variables, the unemployment and the time trend. The second group consisted of implicit deflators, interest rates, relative prices and the rate of indirect taxes.

The detailed presentation of the variables of the two groups is as follows:

A) The first set of 26 variables

1.	Productivity	lagged one period	$(PROD_{t-1})$
2.	Consumption of non-durables	" " "	(CND_{t-1})
3.	Consumption of durables	" " "	(CD_{t-1})
4.	Consumption of services	" " "	(CS_{t-1})
5.	Housing investment	" " "	(HI_{t-1})
6.	Construction investment	" " "	(CI_{t-1})
7.	Equipment investment	" " "	(EI_{t-1})
8.	Imports of goods (0+1 categories)	" " "	$(M01_{t-1})$
9.	Imports of goods (2+4 categories)	" " "	$(M24_{t-1})$
10.	Imports of goods (5+6 categories)	" " "	$(M56_{t-1})$
11.	Imports of goods (8+9 categories)	" " "	$(M89_{t-1})$
12.	Imports of goods (3 category)	" " "	$(M3_{t-1})$
13.	Exports of goods	" " "	(XG_{t-1})

14.	World exports of goods	current period	(WY_t)
15.	World exports of goods	lagged one period	(WY_{t-1})
16.	Inventory investment	" " "	(II_{t-1})
17.	Unemployment	" " "	(UN_{t-1})
18.	Time trend		(T)
19.	GNP nominal (at factor cost)	" " "	($GNPV_{t-1}$)
20.	Non wage income nominal	" " "	($NWYV_{t-1}$)
21.	Final expenditure nominal	" " "	(FEV_{t-1})
22.	Total consumption nominal	" " "	(CV_{t-1})
23.	Housing investment nominal	" " "	(HIV_{t-1})
24.	Change in deposits nominal	" " "	(ΔDEP_{t-1})
25.	Change in loans nominal	" " "	(ΔLO_{t-1})
26.	Change in currency nominal	" " "	(ΔCUR_{t-1})

B) <u>The second set of 13 variables</u>

1.	Consumer price index	lagged one period	(CPI_{t-1})
2.	Implicit deflator of consumption of non-durables	" " "	($PCND_{t-1}$)
3.	Implicit deflator of consumption of durables	" " "	(PCD_{t-1})
4.	Implicit deflator of consumption of services	" " "	(PCS_{t-1})
5.	Implicit deflator of housing investment	" " "	(PHI_{t-1})
6.	Implicit deflator of equipment investment	" " "	(PEI_{t-1})
7.	Implicit deflator of export services	" " "	(PXS_{t-1})
8.	Unit value index of world exports of goods	current period	($PWXG_t$)
9.	Relative price of Greece tourist services	lagged one period	($PG/PT_{1\,t-1}$
10.	Relative price of competitors tourist services	" " "	($PC/PT_{2\,t-1}$

11.	Interest rate of bank long term loans	lagged one period (RL_{t-1})
12.	Interest rate of bank deposits	" " " (RD_{t-1})
13.	Rate of indirect taxes	" " " (RIT_{t-1})

In the case of the simultaneous model,principal components were calculated on all the variables included in each set. For the Block recursive model principal components were calculated on different number of variables from each set. The recursive model consists of three blocks. For the first Block, of the wage-prices equations, components were calculated on the variables 1, 17, 18, 23 of the first set and on the variables 1, 2, 3, 4, 5, 6, 7, 8 and 13 of the second set.

For the second Block, of the financial equations, components were calculated on the variables 1, 17, 18, 19, 23, 24, 25, 26 of the first set, and on the variables 1, 2, 3, 4, 5, 6, 7, 8, 11, 12 and 13 of the second set.

The third Block included all the predetermined variables and thus the components were those of the simultaneous system.

Eigenvalues, percentage of variance (PCV), cumulative percentage of variance (CUM) and factor loadings (without rotation) of the variables used in the block recursive and the simultaneous systems to estimate the reduced form of the model.

The First Block - First Set of Variables

TABLE 1

Number of Factors	Eigenvalue	PCV*	CUM PCV*
1	3.60127	90.0	90.0
2	0.24631	6.2	96.2
3	0.14373	3.6	99.8
4	0.00869	0.2	100.0

*where PCV is the percentage of variance accounted for by each factor and CUM PCV is the cumulative percentage of variance.

TABLE 2

Variables	Factor Loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
$PROD_{t-1}$	0.98489	0.10078	-0.12140	0.07142
UN_{t-1}	-0.90098	0.43362	0.1079	0.00950
T	0.96635	0.18130	-0.17270	-0.05894
HIV_{t-1}	0.94110	0.12350	0.31471	-0.00512

TABLE 3

For the logarithms of these variables the results are as follows:

Number of Factors	Eigenvalue	PCV	CUM PCV
1	3.68806	92.2	92.2
2	0.29111	7.3	99.5
3	0.01521	0.4	99.9
4	0.00562	0.1	100.0

TABLE 4

Variables	Factor Loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
$PROD_{t-1}$	0.98653	0.14329	-0.06270	0.04784
UN_{t-1}	-0.87888	0.47692	0.00923	0.00451
T	0.98126	0.18169	-0.03078	-0.05627
HIV_{t-1}	0.98970	0.10055	0.10121	0.01211

The First Block - Second Set of Variables

TABLE 5

Number of Factors	EigenValue	PCV	CUM PCV
1	8.08815	89.9	89.9
2	0.87993	9.8	99.7
3	0.01653	0.2	99.9
.	....	...	....
5	0.00315	0.0	100.0

TABLE 6

Variables	Factor Loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
CPI_{t-1}	0.99753	-0.06380	0.01023	-0.00925
$PCND_{t-1}$	0.99958	0.01147	-0.00712	-0.00591
PCD_{t-1}	0.99849	-0.02841	0.00154	-0.02965
PCS_{t-1}	0.99877	0.03569	-0.01215	0.00442
PHI_{t-1}	0.99685	-0.01906	-0.04989	-0.05315
PEI_{t-1}	0.99530	0.03243	-0.07058	0.05348
PXS_{t-1}	0.97605	-0.19874	0.08171	-0.00486
$PWXG_{t}$	0.98249	-0.17506	0.03592	0.04435
RIT_{t-1}	0.44396	0.89559	0.02800	0.00282

TABLE 7

For the logarithms of these variables the results are as follows:

Number of Factors	Eigenvalue	PCV	CUM PCV
1	8.07308	89.7	89.7
2	0.87421	9.7	99.4
3	0.02768	0.3	99.7
.	....	...	...
5	0.00668	0.1	99.9

TABLE 8

Variables	Factor Loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
CPI_{t-1}	0.99519	-0.08777	0.02163	-0.00477
$PCND_{t-1}$	0.99862	0.03613	-0.00351	-0.01976
PCD_{t-1}	0.99659	-0.04635	0.02955	-0.02637
PCS_{t-1}	0.99734	0.05619	-0.00764	-0.00904
PHI_{t-1}	0.99617	0.01296	-0.02798	-0.07078
PEI_{t-1}	0.98809	0.08522	-0.11880	0.04166
PXS_{t-1}	0.95254	-0.28360	0.09563	0.03376
$PWXG_{t}$	0.96787	-0.24384	-0.01057	0.04709
RIT_{t-1}	0.53362	0.84415	0.04603	0.02133

The Second Block - First Set of Variables

TABLE 9

Number of Factors	Eigenvalues	PCV	CUM PCV
1	7.06614	88.3	88.3
2	0.56367	7.1	95.4
3	0.23955	3.0	98.4
4	0.08042	1.0	99.4
.	....	...	...
7	0.00743	0.1	100.0

TABLE 10

Variables	Factor Loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
$PROD_{t-1}$	0.93175	-0.31836	0.16036	0.02584
UN_{t-1}	-0.83685	0.39653	0.37571	0.03396
T	0.91708	-0.30171	0.25057	-0.02049
$GNPV_{t-1}$	0.98732	0.12605	0.01882	-0.01299
HIV_{t-1}	0.98107	0.05445	0.01003	0.10068
ΔDEP_{t-1}	0.94385	0.25957	0.00751	-0.20041
ΔLO_{t-1}	0.96934	0.23831	-0.03243	-0.02907
ΔCUR_{t-1}	0.94279	0.26652	-0.07305	0.16390

The Second Block - Second Set of Variables

TABLE 11

Number of Factors	Eigenvalue	PCV	CUM PCV
1	8.59636	78.1	78.1
2	2.10590	19.1	97.2
3	0.22247	2.0	99.2
4	0.05085	0.5	99.7
.	....	....	....
6	0.00579	0.1	100.0

TABLE 12

Variables	Factor Loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
CPI_{t-1}	0.99751	-0.05546	-0.03559	0.00718
$PCND_{t-1}$	0.99135	-0.12763	-0.01266	-0.01214
PCD_{t-1}	0.99399	-0.09286	-0.03181	-0.01580
PCS_{t-1}	0.98670	-0.15802	-0.02232	-0.01372
PHI_{t-1}	0.99204	-0.09766	-0.02141	-0.01026
PEI_{t-1}	0.98117	-0.16954	-0.06076	0.01046
PXS_{t-1}	0.99193	0.08367	-0.05455	-0.02266
$PWXG_{t}$	0.99292	0.04265	-0.09140	0.01294
RL_{t-1}	0.61264	0.75820	0.14248	0.17164
RD_{t-1}	0.49120	0.82849	0.22967	-0.13948
RIT_{t-1}	0.35173	-0.86288	0.36195	0.01999

The Simultaneous System and the Third Block - First Set of Variables

TABLE 13

Number of Factors	Eigenvalue	PCV	CUM PCV
1	22.31940	89.3	89.3
2	1.66040	6.6	95.9
3	0.44163	1.8	97.7
4	0.26368	1.1	98.8
.	....	...	....
8	0.04163	0.2	99.8
.	....	...	....
12	0.00559	0.0	100.0

TABLE 14

Variables	Factor Loadings				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
$PROD_{t-1}$	0.97659	-0.20174	0.00931	0.04525	-0.04933
CND_{t-1}	0.98654	-0.12238	0.01106	0.07992	-0.05865
CD_{t-1}	0.99815	0.00609	0.02854	0.01028	-0.02891
CS_{t-1}	0.99353	-0.08038	0.01902	0.03015	-0.05578
HI_{t-1}	0.86276	-0.42192	0.19686	-0.13042	0.05217
CI_{t-1}	0.88287	-0.44479	0.05898	0.03552	-0.05715
EI_{t-1}	0.96079	-0.25734	-0.04180	0.01845	0.00521
$M01_{t-1}$	0.92327	-0.33255	-0.06928	0.03495	0.09451
$M24_{t-1}$	0.95930	-0.24265	-0.06043	0.05933	0.06016
$M56_{t-1}$	0.96922	-0.23137	-0.01522	0.02573	0.03176
$M89_{t-1}$	0.96713	-0.16040	0.16045	-0.00925	0.06104
$M3_{t-1}$	0.90591	0.32869	-0.20115	0.09084	-0.07078
XG_{t-1}	0.98217	0.15386	-0.04516	0.03740	0.00025
WY_{t}	0.99434	-0.06292	-0.01916	0.03860	-0.02432
WY_{t-1}	0.98752	-0.05983	-0.01428	0.03947	-0.01957
II_{t-1}	0.88242	0.06385	-0.42481	0.06296	0.11969
UN_{t-1}	-0.85348	0.13882	0.25121	0.42202	0.11236
T	0.96024	-0.19179	0.04047	0.12954	-0.10038
$GNPV_{t-1}$	0.95880	0.27843	0.03553	0.00940	0.00339
$NWYV_{t-1}$	0.96864	0.24493	-0.00798	0.01982	0.00479
FEV_{t-1}	0.95627	0.28641	0.03576	0.00974	0.00568
CV_{t-1}	0.95466	0.28661	0.05322	0.01729	-0.00975
HIV_{t-1}	0.96113	0.14016	0.16757	-0.10326	0.10830
ΔDEP_{t-1}	0.90215	0.37029	0.17512	-0.06971	-0.14279
ΔLO_{t-1}	0.92539	0.35588	0.09749	-0.05620	0.00914
ΔCUR_{t-1}	0.91330	0.35569	0.00854	-0.02416	0.15769

For the logarithms of these variables the results are as follows

TABLE 15

Number of Factors	Eigenvalue	PCV	CUM PCV
1	22.15492	88.6	88.6
2	1.41413	5.7	94.3
3	0.75015	3.0	97.3
4	0.30300	1.2	98.5
.	....	....	....
8	0.02910	0.1	99.7
.	....	....	....
12	0.00702	0.0	100.0

TABLE 16

Variables	Factor Loadings				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
$PROD_{t-1}$	0.99391	-0.05048	0.08302	-0.01284	0.01574
CND_{t-1}	0.99406	-0.07012	0.04227	0.04087	-0.03183
CD_{t-1}	0.99403	-0.05091	0.05542	0.04305	-0.05463
CS_{t-1}	0.99445	-0.07347	0.02854	0.02023	0.01412
HI_{t-1}	0.93524	-0.06492	0.27793	-0.15031	0.08369
CI_{t-1}	0.92579	0.08812	0.31196	-0.02864	-0.01374
EI_{t-1}	0.98099	-0.02767	0.15928	-0.03827	-0.04158
$M01_{t-1}$	0.95209	-0.12832	0.15011	-0.09854	-0.06412
$M24_{t-1}$	0.98003	-0.03021	0.11003	-0.03310	-0.02935
$M56_{t-1}$	0.98398	-0.00508	0.14969	-0.01255	0.00847
$M89_{t-1}$	0.97451	-0.01782	0.19258	0.00820	-0.01358
$M3_{t-1}$	0.93329	-0.14266	-0.29330	0.09869	0.02581
XG_{t-1}	0.98074	-0.10313	-0.10489	0.07706	0.01760
WY_{t}	0.99476	-0.07261	0.02275	0.01898	-0.04352
WY_{t-1}	0.98637	-0.06834	0.01928	0.01976	-0.03919
II_{t-1}	0.84029	-0.17355	-0.41882	-0.00392	0.06814
UN_{t-1}	-0.81729	0.12890	0.31091	0.45135	0.14678
T	0.99408	-0.04263	0.04628	0.07087	-0.0952
$GNPV_{t-1}$	0.98435	-0.08131	-0.10307	0.09160	0.03478
$NWYV_{t-1}$	0.98501	-0.08552	-0.11144	0.08179	0.01693
FEV_{t-1}	0.98393	-0.08390	-0.10433	0.09426	0.04817
CV_{t-1}	0.98007	-0.07929	-0.11053	0.11402	0.05210
HIV_{t-1}	0.98704	-0.09752	0.01565	-0.00036	0.00489
ΔDEP_{t-1}	0.79903	0.58896	-0.02344	0.01872	-0.03745
ΔLO_{t-1}	0.74717	0.65463	-0.09249	-0.01772	-0.00832
ΔCUR_{t-1}	0.70673	0.68645	-0.12752	-0.02397	0.09436

TABLE 17

The Simultaneous System and the Third Block - Second Set of Variables

Number of Factors	Eigenvalues	PCV	CUM PCV
1	9.25065	71.2	71.2
2	2.62193	20.2	91.4
3	0.76113	5.9	97.3
4	0.19121	1.5	98.8
.	....	...	....
7	0.00973	0.1	100.0

TABLE 18

Variables	Factor Loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
CPI_{t-1}	0.99513	0.04108	-0.07323	0.04222
$PCND_{t-1}$	0.99754	-0.03737	-0.04590	0.02589
PCD_{t-1}	0.99479	0.00395	-0.07114	0.04991
PCS_{t-1}	0.99450	-0.06530	-0.06453	0.03499
PHI_{t-1}	0.99511	-0.00661	-0.06255	0.01537
PEI_{t-1}	0.99101	-0.08104	-0.09059	-0.01694
PXS_{t-1}	0.97774	0.17917	-0.04366	-0.04401
$PWXG_t$	0.98134	0.13972	-0.09962	0.01501
$(PG/PT_1)_{t-1}$	-0.67433	0.62479	0.13810	0.35060
$(PC/PT_2)_{t-1}$	0.52315	-0.35658	0.76346	-0.06574
RL_{t-1}	0.54669	0.80122	0.08869	-0.01874
RD_{t-1}	0.42904	0.83770	0.29797	-0.05769
RIT_{t-1}	0.42888	-0.83374	0.14797	0.22679

For the logarithms of these variables the results are as follows:

TABLE 19

Number of Factors	Eigenvalues	PCV	CUM PCV
1	9.30145	71.5	71.5
2	2.68800	20.7	92.2
3	0.66061	5.1	97.3
4	0.17429	1.3	98.6
.	....	...	....
7	0.00957	0.1	99.9
.	....	...	....
9	0.00363	0.0	100.0

TABLE 20

Variables	Factor Loadings			
	Factor 1	Factor 2	Factor3	Factor 4
CPI_{t-1}	0.99360	0.07282	-0.06088	0.05275
$PCND_{t-1}$	0.99732	-0.05370	-0.02044	0.03358
PCD_{t-1}	0.99328	0.02858	-0.05947	0.07043
PCS_{t-1}	0.99334	-0.08014	-0.04816	0.05168
PHI_{t-1}	0.99620	-0.02717	-0.02393	0.01241
PEI_{t-1}	0.98411	-0.13102	-0.08775	-0.01629
PXS_{t-1}	0.95457	0.26753	-0.03252	0.06551
$PWXG_t$	0.96736	0.20795	-0.11047	0.01844
$(PG/PT_1)_{t-1}$	-0.73930	0.52885	0.22819	0.34305
$(PC/PT_2)_{t-1}$	0.61113	-0.31055	0.71659	-0.09258
RL_{t-1}	0.45405	0.86371	0.04324	-0.05503
RD_{t-1}	0.37360	0.89094	0.21129	-0.07426
RIT_{t-1}	0.52206	-0.78991	0.13043	0.15134

Tables 21-34 contain:

(i) Orthogonal and Oblique rotated factors which were employed in the estimation of the reduced forms,

(ii) factor scores and the components calculated from them, which were retained in the reduced form regressions.

The varimax method was used in the orthongonal rotation, while for the oblique rotation the oblimin method was employed with δ being the parameter to control the oblique rotation.

TABLE 21

The First Block - First Set of Variables

Variables	Rotated Factors			
	Orthogonal		Oblique $\delta =^{*} -0.7$	
	Factor 1	Factor 2	Factor 1	Factor 2
$PROD_{t-1}$	0.76385	0.46242	1.12488	-0.28852
UN_{t-1}	-0.39232	-0.85665	-0.57751	1.12446
T	0.82125	0.38946	1.21509	-0.22145
HIV_{t-1}	0.48940	0.39525	0.61111	-0.06744

Variables	Factor Score Coefficients			
	Orthogonal		Oblique	
	Factor 1	Factor 2	Factor 1	Factor 2
$PROD_{t-1}$	0.46293	-0.16706	-0.11998	0.30666
UN_{t-1}	0.84330	-1.56549	0.82756	-0.10246
T	0.65276	-0.43323	-0.00522	0.32880
HIV_{t-1}	0.50788	-0.28852	-0.07751	0.30224

$^{*}\delta$ is the parameter which controls the oblique rotation.

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-0.711906	-1.121069	1.216654	-1.327885
-0.773174	-1.028755	1.215916	-1.281386
-0.673292	-0.969401	1.099914	-1.178481
2.475156	-2.527531	-0.641448	-0.854999
-0.703908	-0.757670	1.007054	-1.014219
-0.292178	-0.853283	0.718930	-0.879817
-0.991283	-0.411500	1.052087	-0.870059
-0.955147	-0.311287	0.966141	-0.765774
-0.341818	-0.529939	0.579511	-0.630476
-0.368051	-0.410582	0.534610	-0.542583
-0.142585	-0.411050	0.347849	-0.424793
0.034244	-0.293906	0.135744	-0.232341
-0.025672	-0.090134	0.071634	-0.090215
-0.197619	0.146931	0.081858	0.021538
-1.465197	0.897483	0.714103	-0.003744
-1.023233	0.950718	0.317768	0.273265
-0.751115	1.059918	0.031060	0.508903
0.331009	0.562029	-0.588472	0.652140
1.369382	0.256002	-1.278869	0.935833
1.475086	0.615538	-1.567353	1.297423
1.387352	1.084235	-1.756351	1.650578
1.244233	0.739670	-1.445195	1.282125
0.462498	1.550201	-1.249446	1.562597
0.637218	1.853380	-1.563701	1.912371

The corresponding results for the logarithms of these variables are:

TABLE 22

Variables	Rotated Factors: Orthogonal Factor 1	Orthogonal Factor 2	Oblique $\delta = -0.7$ Factor 1	Oblique $\delta = -0.7$ Factor 2
$PROD_{t-1}$	0.88924	0.45187	1.30953	-0.28194
UN_{t-1}	-0.44337	-0.89629	-0.65266	1.17649
T	0.90714	0.41768	1.34217	-0.23750
HIV_{t-1}	0.86527	0.48668	1.08046	-0.08304

Variables	Factor Score Coefficients: Orthogonal Factor 1	Orthogonal Factor 2	Oblique Factor 1	Oblique Factor 2
$PROD_{t-1}$	0.50171	-0.24921	-0.06447	0.30640
UN_{t-1}	0.74611	-1.47787	0.83251	-0.10511
T	0.57634	-0.35802	-0.01391	0.31564
HIV_{t-1}	0.41808	-0.12855	-0.12006	0.29539

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-0.322160	-1.541732	1.110323	-1.492535
-0.372791	-1.460225	1.108356	-1.447896
-0.391044	-1.245243	1.006500	-1.271769
2.055162	-2.269742	-0.486197	-0.916299
-0.504643	-0.945266	0.938266	-1.070640
-0.330736	-0.833531	0.731561	-0.886222
-0.748086	-0.569496	0.937596	-0.869918
-0.785444	-0.394226	0.873401	-0.737708
-0.471619	-0.414233	0.621177	-0.596025
-0.518644	-0.242878	0.567220	-0.472087
-0.407718	-0.154601	0.426106	-0.339792
-0.340194	0.068188	0.248075	-0.113492
-0.410410	0.293788	0.184002	0.045474
-0.554881	0.514611	0.184789	0.162716
-1.396893	0.997176	0.627790	0.152385
-1.171147	1.165726	0.346657	0.412047
-0.999419	1.294116	0.132701	0.609723
-0.124918	0.932299	-0.403344	0.740625
1.242759	0.437497	-1.280419	1.006623
1.770994	0.435984	-1.722494	1.272837
2.040488	0.530400	-1.999906	1.490731
1.328788	0.716105	-1.504386	1.290425
0.425032	1.387283	-1.112406	1.411457
0.987523	1.297999	-1.535369	1.619339

The First Block - Second Set of Variables

TABLE 23

Variables	Rotated Factors: Orthogonal Factor 1	Orthogonal Factor 2	Oblique $\delta = 0.5$ Factor 1	Oblique $\delta = 0.5$ Factor 2
CPI_{t-1}	0.97838	0.20495	0.98580	0.02227
$PCND_{t-1}$	0.96012	0.27745	0.98021	-0.18200
PCD_{t-1}	0.96980	0.23894	1.01394	-0.04240
PCS_{t-1}	0.95283	0.30044	1.01820	-0.46465
PHI_{t-1}	0.96538	0.24578	0.98033	-0.05623
PEI_{t-1}	0.94992	0.29470	0.97734	-0.65711
PXS_{t-1}	0.99422	0.07154	0.97502	0.03946
$PWXG_{t}$	0.99375	0.09479	1.02265	0.04450
RIT_{t-1}	0.18879	0.98199	0.24553	1.12697

Variables	Factor Score Coefficients: Orthogonal Factor 1	Orthogonal Factor 2	Oblique Factor 1	Oblique Factor 2
CPI_{t-1}	0.13821	-0.03695	0.12211	0.02101
$PCND_{t-1}$	0.11562	0.04555	0.12379	0.08775
PCD_{t-1}	0.12579	0.00184	0.12290	0.05239
PCS_{t-1}	0.10818	0.07205	0.12414	0.10910
PHI_{t-1}	0.12456	0.01203	0.12287	0.06053
PEI_{t-1}	0.10875	0.06838	0.12365	0.10596
PXS_{t-1}	0.17660	-0.18545	0.11690	-0.10000
$PWXG_{t}$	0.17018	-0.15930	0.11815	-0.07856
T_{t-1}	-0.21883	0.99551	0.07180	0.82659

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-0.511283	-1.439728	-0.937849	-1.625296
-0.533927	-1.462892	-0.927713	-1.555303
-0.428829	-1.416652	-0.813583	-1.471006
-0.307865	-1.485120	-0.716533	-1.485600
-0.323044	-1.286615	-0.674949	-1.309482
-0.410580	-0.866638	-0.640046	-0.958858
-0.441009	-0.660016	-0.610558	-0.781255
-0.445669	-0.529482	-0.578054	-0.665305
-0.514885	-0.156717	-0.538996	-0.348749
-0.497428	0.003415	-0.476981	-0.194881
-0.499218	0.331436	-0.385808	0.105454
-0.468451	0.334053	-0.355495	0.120107
-0.428605	0.437597	-0.287846	0.231014
-0.502967	1.210094	-0.140347	0.910458
-0.499627	1.320848	-0.105653	1.013483
-0.550582	1.614008	-0.071548	1.262267
-0.479763	1.548757	-0.022005	1.230564
-0.267669	1.149283	0.068555	0.948327
-0.149678	1.042498	0.151577	0.897249
0.102247	0.808462	0.327165	0.782663
0.879427	0.021962	0.851002	0.370147
1.936622	-0.697766	1.663017	0.130471
2.373444	0.019822	2.285961	0.962943
2.991984	0.182556	2.926548	1.358594

The corresponding results for the logarithms of these variables are:

TABLE 24

Variables	Rotated Factors: Orthogonal Factor 1	Orthogonal Factor 2	Oblique $\delta = 0.5$ Factor 1	Oblique $\delta = 0.5$ Factor 2
CPI_{t-1}	0.96269	0.26715	1.01527	-0.02813
$PCND_{t-1}$	0.92167	0.38254	0.92118	0.12464
PCD_{t-1}	0.94952	0.30622	0.98406	0.02295
PCS_{t-1}	0.91338	0.40091	0.90421	0.14923
PHI_{t-1}	0.92672	0.35749	0.93706	0.09592
PEI_{t-1}	0.89213	0.42045	0.87260	0.18421
PXS_{t-1}	0.99355	0.07383	1.12857	-0.27260
$PWXG_{t}$	0.99147	0.11131	1.11191	-0.22244
RIT_{t-1}	0.20376	0.97893	-0.15582	1.08187

Variables	Factor Score Coefficients: Orthogonal Factor 1	Orthogonal Factor 2	Oblique Factor 1	Oblique Factor 2
CPI_{t-1}	0.15067	-0.05074	0.12955	0.00113
$PCND_{t-1}$	0.10132	0.08211	0.12075	0.11065
PCD_{t-1}	0.13420	-0.00632	0.12664	0.03776
PCS_{t-1}	0.09312	0.10355	0.11909	0.12824
PHI_{t-1}	0.11034	0.05719	0.12217	0.09002
PEI_{t-1}	0.08039	0.13424	0.11579	0.15311
PXS_{t-1}	0.22435	-0.26235	0.13885	-0.17492
G_{t}	0.21016	-0.21910	0.13779	-0.13866
$_{t-1}$	-0.27703	0.92737	0.00311	0.78648

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-0.657836	-1.569841	-1.116328	-1.724083
-0.648776	-1.512198	-1.058535	-1.641082
-0.453226	-1.492991	-0.865791	-1.559200
-0.249563	-1.609834	-0.704639	-1.603296
-0.279946	-1.349301	-0.658348	-1.366883
-0.418334	-0.858104	-0.648710	-0.947592
-0.473992	-0.591027	-0.624719	-0.713229
-0.494758	-0.410061	-0.592240	-0.548907
-0.584926	-0.044477	-0.572787	-0.232659
-0.559623	0.137232	-0.495997	-0.052623
-0.529579	0.397014	-0.392081	0.202772
-0.484322	0.399125	-0.348148	0.219515
-0.430771	0.512279	-0.264148	0.343945
-0.492031	1.153338	-0.137324	0.930053
-0.496825	1.274713	-0.106797	1.043242
-0.554079	1.519399	-0.090812	1.255915
-0.452712	1.444352	-0.015491	1.217996
-0.198713	1.129681	0.136612	1.003269
-0.054953	1.041309	0.248660	0.966568
0.255760	0.803776	0.477370	0.843249
1.124825	0.023551	1.083555	0.388809
2.099966	-0.648295	1.822634	0.071405
2.330364	0.013675	2.234695	0.772326
2.694991	0.179042	2.631577	1.047490

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-0.024010	-1.58372	-0.885607	1.564855
-0.059861	-1.514525	-0.877746	1.491342
-0.137147	-1.336168	-0.845009	1.303936
-0.932936	0.056748	-0.750327	-0.186495
-0.147092	-1.131281	-0.741378	1.099667
-0.377882	-0.772032	-0.738354	0.711700
-0.218133	-0.968514	-0.711931	0.928569
-0.255019	-0.817821	-0.660477	0.774200
-0.483242	-0.413710	-0.630789	0.342169
-0.428961	-0.363279	-0.557769	0.299812
-0.461244	-0.169098	-0.478697	0.103022
-0.565590	0.133275	-0.400856	-0.210966
-0.640600	0.321500	-0.360822	-0.407824
-0.536974	0.349847	-0.258544	-0.421421
-0.159978	-0.099484	-0.188347	0.076168
-0.396115	0.392421	-0.117308	-0.443902
-0.312614	0.619318	0.076613	-0.656915
-0.377000	1.037620	0.251268	-1.080117
-0.313802	1.458376	0.534120	-1.487931
0.209033	1.457762	0.971663	-1.414305
0.207239	1.779492	1.145968	-1.733135
0.883231	1.130285	1.357346	-0.995863
2.123261	0.443518	2.020598	-0.142627
3.405526	-0.010528	2.846385	0.486062

The Second Block - First Set of Variables

TABLE 25

Variables	Rotated Factors: Orthogonal Factor 1	Orthogonal Factor 2	Oblique $\delta = -0.44$ Factor 1	Oblique $\delta = -0.44$ Factor 2
$PROD_{t-1}$	0.45662	0.78349	0.67244	-0.48855
UN_{t-1}	-0.36519	-0.42645	-0.53757	0.55977
T	0.45206	0.82329	0.66885	-0.46812
$GNPV_{t-1}$	0.80723	0.48404	0.99072	-0.01078
HIV_{t-1}	0.75434	0.51660	0.94194	-0.08815
ΔDEP_{t-1}	0.86707	0.37607	1.03058	0.14183
ΔLO_{t-1}	0.87327	0.38073	1.04144	0.11474
ΔCUR_{t-1}	0.87497	0.33070	1.03377	0.14960

Variables	Factor Score Coefficients: Orthogonal Factor 1	Orthogonal Factor 2	Oblique Factor 1	Oblique Factor 2
$PROD_{t-1}$	-0.27067	0.51295	0.05361	-0.54573
UN_{t-1}	0.37172	-0.60887	-0.02140	0.64483
T	-0.25287	0.48928	0.05559	-0.51981
$GNPV_{t-1}$	0.25211	-0.07727	0.16891	0.11173
HIV_{t-1}	0.16817	0.01806	0.15072	0.00560
ΔDEP_{t-1}	0.40275	-0.26020	0.19512	0.31390
ΔLO_{t-1}	0.38074	-0.22934	0.19355	0.28028
ΔCUR_{t-1}	0.41072	-0.26961	0.19665	0.32433

The Second Block - Second Set of Variables

TABLE 26

Variables	Rotated Factors			
	Orthogonal		Oblique $\delta = 0.7$	
	Factor 1	Factor 2	Factor 1	Factor 2
CPI_{t-1}	0.98593	0.16136	0.99341	0.01753
$PCND_{t-1}$	0.99551	0.08956	1.01641	-0.05875
PCD_{t-1}	0.99057	0.12408	1.00501	-0.02202
PCS_{t-1}	0.99753	0.05888	1.02409	-0.09103
PHI_{t-1}	0.98971	0.11897	1.00504	-0.02722
PEI_{t-1}	0.99463	0.04644	1.02334	-0.10355
PXS_{t-1}	0.95043	0.29599	0.93208	0.16325
$PWXG_{t}$	0.96026	0.25616	0.94953	0.12024
RL_{t-1}	0.43437	0.87265	0.29183	0.84300
RD_{t-1}	0.30061	0.91505	0.14536	0.90761
RIT_{t-1}	0.52984	-0.76652	0.68909	-0.87969

Variables	Factor Score Coefficients			
	Orthogonal		Oblique	
	Factor 1	Factor 2	Factor 1	Factor 2
CPI_{t-1}	0.11899	-0.00064	0.11764	0.01992
$PCND_{t-1}$	0.12569	-0.03426	0.11939	-0.01203
PCD_{t-1}	0.12242	-0.01807	0.11851	0.00335
PCS_{t-1}	0.12828	-0.04847	0.11989	-0.02558
PHI_{t-1}	0.12270	-0.02035	0.11845	0.00115
PEI_{t-1}	0.12884	-0.05395	0.11965	-0.03088
PXS_{t-1}	0.10408	0.06372	0.11222	0.08074
$PWXG_{t}$	0.10840	0.04473	0.11374	0.06278
RL_{t-1}	-0.00820	0.36693	0.04511	0.36000
RD_{t-1}	-0.02921	0.39647	0.02861	0.38546
RIT_{t-1}	0.12847	-0.39123	0.07037	-0.36316

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-1.073164	1.348251	-0.836174	1.122397
-1.029741	1.289289	-0.831846	1.092033
-0.908038	0.992350	-0.754500	0.820578
-0.867653	1.895380	-0.583553	1.717005
-0.796379	1.563750	-0.561137	1.402674
-0.719015	1.147944	-0.544903	1.006485
-0.650032	0.414113	-0.583092	0.295602
-0.573440	-0.414248	-0.627466	-0.507075
-0.508616	-0.624754	-0.593861	-0.703219
-0.437373	-0.696752	-0.533814	-0.761828
-0.328042	-0.834091	-0.445558	-0.878218
-0.297757	-0.839181	-0.416331	-0.877999
-0.224456	-0.888599	-0.350974	-0.914012
-0.045687	-0.947108	-0.182576	-0.940764
-0.004565	-0.995799	-0.148950	-0.981619
0.046449	-1.114412	-0.115678	-1.089638
0.091872	-1.095588	-0.068007	-1.063250
0.159174	-0.955687	0.018874	-0.913825
0.236071	-0.928639	0.098879	-0.873900
0.397688	-0.865246	0.267979	-0.783541
0.844263	-0.056309	0.827165	0.090375
1.543156	1.389180	1.728336	1.634859
2.213580	0.901340	2.320910	1.270162
2.888282	0.373775	2.911951	0.867082

Simultaneous System and the Third Block - First Set of Variables

TABLE 27

Variables	Rotated Factors			
	Orthogonal			
	Factor 1	Factor 2	Factor 3	Factor 4
$PROD_{t-1}$	0.52883	0.81631	0.19535	0.11123
CND_{t-1}	0.59193	0.77032	0.21245	0.07641
CD_{t-1}	0.69361	0.68429	0.17673	0.12913
CS_{t-1}	0.62776	0.74242	0.18879	0.11802
HI_{t-1}	0.32971	0.90854	-0.07304	0.19658
CI_{t-1}	0.30230	0.93089	0.11891	0.09973
EI_{t-1}	0.46947	0.83438	0.22539	0.15504
$M01_{t-1}$	0.38573	0.85889	0.24614	0.14818
$M24_{t-1}$	0.47543	0.82355	0.25843	0.12354
$M56_{t-1}$	0.49841	0.82664	0.20708	0.13853
$M89_{t-1}$	0.57903	0.79989	0.03808	0.10181
$M3_{t-1}$	0.81597	0.36381	0.40869	0.11057
XG_{t-1}	0.77341	0.55963	0.25609	0.12186
WY_t	0.63367	0.72531	0.22720	0.12366
WY_{t-1}	0.61473	0.69185	0.23638	0.09842
II_{t-1}	0.57236	0.49702	0.58345	0.22831
UN_{t-1}	-0.44108	-0.60618	-0.22369	-0.61389
T	0.53036	0.81027	0.19762	0.01959
$GNPV_{t-1}$	0.85991	0.46599	0.17270	0.10804
$NWYV_{t-1}$	0.83511	0.49040	0.21668	0.11771
FEV_{t-1}	0.86385	0.45869	0.17263	0.11687
CV_{t-1}	0.86608	0.46086	0.15963	0.09325
HIV_{t-1}	0.78806	0.57649	0.00529	0.16955
ΔDEP_{t-1}	0.91126	0.37763	0.00894	0.11588
ΔLO_{t-1}	0.90288	0.39258	0.08794	0.13639
ΔCUR_{t-1}	0.87826	0.37311	0.17792	0.13814

TABLE 28

Rotated Factors				
Variables	Oblique		$\delta = 0.5$	
	Factor 1	Factor 2	Factor 3	Factor 4
$PROD_{t-1}$	1.54432	0.06405	-0.34320	0.34958
CND_{t-1}	1.43285	0.35891	-0.38777	0.49883
CD_{t-1}	0.80973	0.77322	-0.33410	0.31774
CS_{t-1}	1.13715	0.48288	-0.34627	0.34738
HI_{t-1}	1.55618	-0.66686	0.19738	0.12794
CI_{t-1}	2.19012	-0.77101	-0.16748	0.37547
EI_{t-1}	1.59367	-0.20137	-0.39012	0.10419
$M01_{t-1}$	1.84433	-0.49801	-0.41968	0.7031
$M24_{t-1}$	1.68682	-0.14800	-0.45613	0.20784
$M56_{t-1}$	1.55373	-0.07698	-0.35992	0.20694
$M89_{t-1}$	1.25842	0.31738	-0.05220	0.55001
$M3_{t-1}$	-0.02220	1.59879	-0.81397	0.06012
XG_{t-1}	0.42310	1.19663	-0.50327	0.25137
WY_{t}	1.10433	0.50789	-0.42070	0.28256
WY_{t-1}	1.08517	0.47634	-0.43923	0.29194
II_{t-1}	0.61003	0.45146	-1.10275	-0.68170
UN_{t-1}	0.45760	0.35804	0.37577	2.04984
T	1.80611	0.16749	-0.35379	0.73757
$GNPV_{t-1}$	-0.05253	1.66207	-0.36300	0.37910
$NWYV_{t-1}$	0.08265	1.51892	-0.44083	0.29928
FEV_{t-1}	-0.07758	1.68738	-0.36359	0.38203
CV_{t-1}	-0.04832	1.70922	-0.33982	0.45479
HIV_{t-1}	0.00843	1.26933	-0.02538	0.28362
DEP_{t-1}	-0.61924	2.02397	-0.06463	0.45984
LO_{t-1}	-0.52972	1.92127	-0.21086	0.30910
CUR_{t-1}	-0.44901	1.84016	-0.38046	0.19224

Variables	Factor Score Coefficients			
	Orthogonal		Oblique	
	Factor 1	Factor 2	Factor 1	Factor 2
$PROD_{t-1}$	-0.05174	0.13387	0.04902	0.00853
CND_{t-1}	-0.01696	0.11234	0.02222	-0.00849
CD_{t-1}	0.04504	0.04160	0.04503	0.04694
CS_{t-1}	0.00429	0.08132	0.04382	0.02733
HI_{t-1}	-0.07159	0.23403	0.21341	0.16609
CI_{t-1}	-0.13732	0.24904	0.09621	0.01637
EI_{t-1}	-0.09699	0.12998	0.05456	0.00489
$M01_{t-1}$	-0.14139	0.15636	0.04703	-0.01959
$M24_{t-1}$	-0.09841	0.13033	0.02704	-0.02622
$M56_{t-1}$	-0.07471	0.13109	0.05538	0.01080
$M89_{t-1}$	0.02783	0.15242	0.11281	0.09463
$M3_{t-1}$	0.08448	-0.15457	-0.10667	-0.06999
XG_{t-1}	0.07690	-0.03934	-0.00958	0.01119
WY_{t}	-0.00402	0.06298	0.02655	0.01007
WY_{t-1}	-0.00274	0.05162	0.01984	0.00966
II_{t-1}	-0.12110	-0.13189	-0.12185	-0.14055
UN_{t-1}	0.13722	0.14242	-0.19298	-0.20931
T	-0.03500	0.16779	0.01409	-0.03373
$GNPV_{t-1}$	0.16235	-0.07325	0.00950	0.06025
$NWYV_{t-1}$	0.13048	-0.07091	-0.00308	0.03808
FEV_{t-1}	0.16576	-0.07653	0.00823	0.06036
CV_{t-1}	0.17302	-0.06795	0.00933	0.06146
HIV_{t-1}	0.15804	-0.00374	0.12109	0.16865
ΔDEP_{t-1}	0.25711	-0.08982	0.07345	0.15797
)$_{t-1}$	0.21968	-0.10640	0.04774	0.12387
JR_{t-1}	0.18255	-0.12814	0.00625	0.07353

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-0.272197	-1.369739	-1.287240	-1.063644
-0.272249	-1.345102	-1.283732	-1.066340
-0.339042	-1.265631	-1.217624	-1.035417
-0.663892	-1.351541	-0.702866	-0.534246
-0.384880	-1.109655	-1.146877	-1.018572
-0.454827	-0.908847	-0.939544	-0.857087
-0.283423	-0.784590	-0.960068	-0.865772
-0.338865	-0.611897	-0.851917	-0.808016
-0.512443	-0.545221	-0.733554	-0.744929
-0.387617	-0.421121	-0.591391	-0.590419
-0.461999	-0.287000	-0.470314	-0.518603
-0.584492	-0.035681	-0.258076	-0.387494
-0.732248	0.312001	-0.093268	-0.339325
-0.503528	0.556430	0.097477	-0.135742
-0.289834	0.600123	-0.081787	-0.300607
-0.278222	1.083803	0.371841	0.080919
-0.318047	1.341425	0.667049	0.314148
-0.330533	1.087431	0.703904	0.390082
-0.183129	1.411718	1.265093	0.953199
0.301468	1.672651	1.800760	1.575142
0.112541	1.812497	1.875484	1.529586
1.146532	0.283690	0.923263	1.088915
2.392613	0.043376	1.191506	1.718785
3.638311	-0.169126	1.721882	2.615438

The corresponding results for the logarithms of these variables are:

TABLE 29

Variables	Rotated Factors			
	Orthogonal			
	Factor 1	Factor 2	Factor 3	Factor 4
$PROD_{t-1}$	0.75997	0.52941	0.34622	0.14062
CND_{t-1}	0.73391	0.57969	0.33420	0.10089
CD_{t-1}	0.73860	0.56460	0.34997	0.09398
CS_{t-1}	0.72652	0.58440	0.33278	0.12429
HI_{t-1}	0.86200	0.32866	0.28353	0.21744
CI_{t-1}	0.83961	0.28141	0.41556	0.07849
EI_{t-1}	0.79933	0.45482	0.35187	0.14262
$M01_{t-1}$	0.79769	0.46248	0.24942	0.20682
$M24_{t-1}$	0.76533	0.49005	0.35536	0.14969
$M56_{t-1}$	0.78873	0.46253	0.37505	0.11886
$M89_{t-1}$	0.81319	0.43855	0.35459	0.08835
$M3_{t-1}$	0.47540	0.81469	0.28625	0.12439
XG_{t-1}	0.62956	0.69399	0.31761	0.10289
WY_{t}	0.72266	0.58784	0.33438	0.12686
WY_{t-1}	0.68134	0.51792	0.34614	0.11197
II_{t-1}	0.33661	0.82737	0.23498	0.24202
UN_{t-1}	-0.40619	-0.59501	-0.24735	-0.63620
T	0.72925	0.57598	0.35897	0.06892
$GNPV_{t-1}$	0.62788	0.69134	0.33878	0.08721
$NWYV_{t-1}$	0.62401	0.69603	0.33616	0.09907
FEV_{t-1}	0.62716	0.69364	0.33646	0.08514
CV_{t-1}	0.61829	0.69975	0.34008	0.06680
HIV_{t-1}	0.71878	0.59139	0.30934	0.14807
ΔDEP_{t-1}	0.41149	0.27244	0.86013	0.05338
ΔLO_{t-1}	0.31577	0.25558	0.90676	0.09180
ΔCUR_{t-1}	0.25711	0.24299	0.92349	0.09768

TABLE 30

Variables	Rotated Factors			
	Oblique		δ = 0.5	
	Factor 1	Factor 2	Factor 3	Factor 4
$PROD_{t-1}$	1.42971	-0.19219	0.20189	0.1413
CND_{t-1}	1.50619	-0.24308	0.08468	0.25512
CD_{t-1}	1.50390	-0.18998	0.10340	0.29180
CS_{t-1}	1.44140	-0.25249	0.09529	0.16753
HI_{t-1}	1.43147	-0.24484	0.55975	-0.08881
CI_{t-1}	1.50388	0.18615	0.50462	0.46007
EI_{t-1}	1.45953	-0.13266	0.31946	0.16585
$M01_{t-1}$	1.43638	-0.41447	0.34002	-0.11747
$M24_{t-1}$	1.38421	-0.13698	0.26165	0.12010
$M56_{t-1}$	1.46621	-0.06821	0.28724	0.25499
$M89_{t-1}$	1.59911	-0.10489	0.29830	0.36692
$M3_{t-1}$	1.06524	-0.42365	-0.36751	-0.02624
XG_{t-1}	1.35514	-0.32586	-0.12609	0.16829
WY_{t}	1.42710	-0.24986	0.09137	0.15684
WY_{t-1}	1.38961	-0.22007	0.09438	0.16290
II_{t-1}	0.54484	-0.50279	-0.39073	-0.55335
UN_{t-1}	0.34898	0.39830	-0.29733	1.87218
T	1.53548	-0.16535	0.06262	0.37823
$GNPV_{t-1}$	1.35984	-0.26458	-0.13290	0.23407
$NWYV_{t-1}$	1.33052	-0.27631	-0.13078	0.18844
FEV_{t-1}	1.36709	-0.27164	-0.13866	0.23948
CV_{t-1}	1.38734	-0.25756	-0.16835	0.29993
HIV_{t-1}	1.40209	-0.31949	0.09703	0.06603
ΔDEP_{t-1}	0.03303	1.61193	0.29857	0.53081
ΔLO_{t-1}	-0.34329	1.80032	0.29530	0.36380
CUR_{t-1}	-0.52214	1.89281	0.27589	0.31689

Variables	Factor Score Coefficients			
	Orthogonal		Oblique	
	Factor 1	Factor 2	Factor 1	Factor 2
$PROD_{t-1}$	0.11658	-0.04892	0.03068	-0.00257
CND_{t-1}	0.07394	0.04440	0.03804	0.00564
CD_{t-1}	0.08263	0.02980	0.03621	0.00587
CS_{t-1}	0.06526	0.03783	0.03976	0.01019
HI_{t-1}	0.31628	-0.35497	-0.00570	-0.07515
CI_{t-1}	0.30412	-0.30741	-0.00738	-0.05083
EI_{t-1}	0.18615	-0.14829	0.01778	-0.02384
$M01_{t-1}$	0.20192	-0.17345	0.01565	-0.04645
$M24_{t-1}$	0.14085	-0.09821	0.02558	-0.00704
$M56_{t-1}$	0.16995	-0.12050	0.02019	-0.01503
$M89_{t-1}$	0.20735	-0.13639	0.01332	-0.03456
$M3_{t-1}$	-0.23152	0.41972	0.08868	0.10303
XG_{t-1}	-0.6114	0.22004	0.06106	0.04832
WY_t	0.06007	0.04166	0.04066	0.01253
$W\ddot{Y}_{t-1}$	0.05814	0.02985	0.03212	0.00816
II_{t-1}	-0.32763	0.43991	0.10182	0.13861
UN_{t-1}	0.16573	0.09902	-0.07483	-0.12129
T	0.06860	0.06271	0.03832	0.01064
$GNPV_{t-1}$	-0.06502	0.22699	0.06146	0.05314
$NWYV_{t-1}$	-0.07042	0.22641	0.06256	0.05530
FEV_{t-1}	-0.06621	0.23131	0.06167	0.05284
CV_{t-1}	-0.07583	0.25465	0.06294	0.05563
HIV_{t-1}	0.06026	0.03553	0.04078	0.00874
ΔDEP_{t-1}	-0.08951	-0.08747	0.04582	0.19309
ΔLO_{t-1}	-0.15826	-0.07784	0.05427	0.23364
UR_{t-1}	-0.19530	-0.06121	0.05817	0.25297

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-2.519809	-1.893861	-0.646621	0.553771
-2.507118	-1.874183	-0.638651	0.545248
-2.175347	-2.156078	-0.615740	0.556708
-1.209738	-1.204990	-0.772298	0.760686
-1.713969	-1.348881	-0.450655	0.376781
-1.152528	-2.086940	-0.514627	0.530643
-1.404523	-1.454923	-0.330481	0.300687
-1.182408	-1.005835	-0.231993	0.201327
-0.687953	-1.202734	-0.358241	0.369246
-0.659330	-0.633815	-0.181930	0.174911
-0.362855	-0.495429	-0.126146	0.130215
0.113324	-0.206185	-0.146669	0.175451
0.539639	-0.665008	-0.121302	0.198934
0.558559	-0.666850	0.118395	-0.030829
0.209052	-0.069808	0.331699	-0.312073
0.944986	-1.264981	0.251017	-0.105519
1.158746	-0.305121	0.375334	-0.261552
1.498947	0.744085	0.202750	-0.132873
1.828702	1.450199	0.344810	-0.260150
1.887251	2.554727	0.617166	-0.570101
2.504461	2.750750	0.385609	-0.335381
1.526917	3.198988	0.593984	-0.681895
1.382464	3.386733	0.839764	-0.953922
1.422532	4.450141	1.074824	-1.230312

Simultaneous System and the Third Block - Second Set of Variables

TABLE 31

Variables	Rotated Factors			
	Orthogonal			
	Factor 1	Factor 2	Factor 3	Factor 4
CPI_{t-1}	0.97102	0.14514	0.18546	-0.02783
$PCND_{t-1}$	0.96623	0.08241	0.23723	-0.05098
PCD_{t-1}	0.97202	0.10987	0.19916	-0.02468
PCS_{t-1}	0.97050	0.04911	0.22838	-0.04732
PHI_{t-1}	0.96672	0.10747	0.21181	-0.05909
PEI_{t-1}	0.96999	0.03364	0.21104	0.10296
PXS_{t-1}	0.94180	0.28043	0.16213	-0.00440
$PWXG_{t}$	0.95972	0.23170	0.12653	-0.04413
$(PG/PT_1)_{t-1}$	-0.66591	0.48433	-0.27455	0.48340
$(PC/PT_2)_{t-1}$	0.28166	-0.02956	0.95074	-0.06262
RL_{t-1}	0.46767	0.85207	-0.03560	0.05500
RD_{t-1}	0.29018	0.93732	0.11173	0.05159
RIT_{t-1}	0.41409	-0.71102	0.51401	0.10565

TABLE 32

Variables	Rotated Factors			
	Oblique		$\delta = 0.50$	
	Factor 1	Factor 2	Factor 3	Factor 4
CPI_{t-1}	1.69773	0.27549	-0.28883	0.27899
$PCND_{t-1}$	1.59161	0.17674	-0.22169	0.31837
PCD_{t-1}	1.70562	0.25270	-0.27635	0.32746
PCS_{t-1}	1.62820	0.14349	-0.26278	0.35995
PHI_{t-1}	1.58657	0.16778	-0.27302	0.26874
PEI_{t-1}	1.49086	-0.03014	-0.35897	0.26906
PXS_{t-1}	1.68812	0.47222	-0.21820	0.15611
$PWXG_{t}$	1.65970	0.29243	-0.37846	0.13242
$(PG/PT_1)_{t-1}$	0.12043	1.58764	0.59807	-0.01614
$(PC/PT_1)_{t-1}$	-0.48120	0.42266	1.91653	0.34207
RL_{t-1}	0.91004	1.11322	0.09947	-0.62125
RD_{t-1}	0.37498	1.28087	0.63475	-0.75067
RIT_{t-1}	0.86297	-0.17176	0.52254	1.30304

Variables	Orthogonal		Oblique	
	Factor 1	Factor 2	Factor 1	Factor 2
CPI_{t-1}	0.15182	-0.03047	0.07284	-0.00422
$PCND_{t-1}$	0.13406	-0.03575	0.08612	-0.04808
PCD_{t-1}	0.15547	-0.04864	0.06820	0.00139
PCS_{t-1}	0.14593	-0.05971	0.07833	-0.03577
PHI_{t-1}	0.13425	-0.02341	0.09090	-0.05737
PEI_{t-1}	0.12842	-0.03682	0.10835	-0.11899
PXS_{t-1}	0.13810	0.02863	0.07243	0.02107
$PWXG_{t}$	0.14498	0.01458	0.08593	-0.02627
$(PG/PT_1)_{t-1}$	0.05462	0.00573	-0.28172	0.72057
$(PC/PT_2)_{t-1}$	-0.26635	0.22378	0.17011	-0.30955
RL_{t-1}	0.00319	0.34203	0.07750	0.05208
RD_{t-1}	-0.10925	0.46302	0.10921	-0.01954
RIT_{t-1}	0.11678	-0.40280	-0.08223	0.16248

Table heading: Factor Score Coefficients

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-0.698354	1.032678	-0.781169	0.980746
-0.675833	1.014727	-0.739784	0.965026
-0.494533	0.718423	-0.967625	1.525951
-1.115794	2.170796	-0.349507	0.957716
-0.684600	1.556823	-0.711311	1.613152
-0.722375	1.217503	-0.636878	1.312493
-0.471543	0.284440	-0.577341	0.631571
-0.360987	-0.547409	-0.768863	0.646789
-0.272760	-0.806267	-0.715251	0.451445
-0.271956	-0.817798	-0.640731	0.357799
-0.305535	-0.849387	-0.496076	0.138160
-0.385384	-0.768691	-0.369287	-0.91959
-0.383394	-0.765500	-0.251613	-0.277961
-0.268864	-0.769573	-0.262844	0.052141
-0.146757	-0.879154	-0.334700	0.233644
-0.120527	-1.002388	-0.230382	-0.030317
-0.050563	-1.024116	-0.098736	-0.302086
0.033728	-0.893922	0.053397	-0.500993
0.215723	-0.997914	0.306925	-1.083682
0.117321	-0.712945	0.678698	-1.612779
0.524222	0.172099	1.146377	-1.480031
1.444010	1.473338	1.747808	-0.952394
1.921685	1.120707	2.327212	-1.594676
3.150548	0.091480	2.630293	-1.924036

The corresponding results for the logarithms of these variables are:

TABLE 33

Variables	Rotated Factors			
	Orthogonal			
	Factor 1	Factor 2	Factor 3	Factor 4
CPI_{t-1}	0.95896	0.18796	0.20740	-0.03298
$PCND_{t-1}$	0.95426	0.07882	0.28021	-0.06107
PCD_{t-1}	0.96306	0.14314	0.21794	-0.02137
PCS_{t-1}	0.96265	0.04447	0.25843	-0.05179
PHI_{t-1}	0.94982	0.10663	0.27230	-0.07867
PEI_{t-1}	0.95845	-0.00291	0.24042	-0.13100
PXS_{t-1}	0.90563	0.37244	0.17047	0.01353
$PWXG_{t}$	0.93698	0.30869	0.12360	-0.05547
$(PG/PT_1)_{t-1}$	-0.74236	0.39500	-0.18087	0.50612
$(PC/PT_2)_{t-2}$	0.36753	-0.04999	0.92305	-0.04890
RL_{t-1}	0.36330	0.90671	-0.04481	0.03066
RD_{t-1}	0.23366	0.95892	0.08080	0.05336
RIT_{t-1}	0.51618	-0.67905	0.45643	0.02360

TABLE 34

Variables	Rotated Factors: Oblique Factor 1	Oblique Factor 2	$\delta = 0.5$ Factor 3	$\delta = 0.5$ Factor 4
CPI_{t-1}	1.81100	0.29602	-0.40306	0.34543
$PCND_{t-1}$	1.61383	0.19710	-0.27382	0.28579
PCD_{t-1}	1.85391	0.18158	-0.42168	0.44730
PCS_{t-1}	1.70022	0.08901	-0.37977	0.35531
PHI_{t-1}	1.54692	0.29502	-0.25974	0.16167
PEI_{t-1}	1.43271	0.19221	-0.43587	-0.07627
PXS_{t-1}	1.88316	0.53550	-0.30080	0.44487
$PWXG_t$	1.77589	0.55159	-0.50087	0.08918
$(PG/PT_1)_{t-1}$	0.30474	-0.42145	0.53490	2.11545
$(PG/PT_2)_{t-1}$	-0.55012	0.46837	2.15759	0.39263
RL_{t-1}	0.90814	1.58804	0.20694	-0.21185
RD_{t-1}	0.51499	1.74640	0.75974	0.13321
RIT_{t-1}	0.75696	-1.29533	0.06913	1.07671

Variables	Factor Score Coefficients			
	Orthogonal		Oblique	
	Factor 1	Factor 2	Factor 1	Factor 2
CPI_{t-1}	0.17012	-0.02550	0.07643	-0.01314
$PCND_{t-1}$	0.13902	-0.04065	0.09964	-0.06062
PCD_{t-1}	0.18490	-0.05671	0.07894	-0.02575
PCS_{t-1}	0.16645	-0.07500	0.09706	-0.06489
PHI_{t-1}	0.12247	-0.01326	0.09970	-0.05407
PEI_{t-1}	0.12804	-0.04434	0.11163	-0.08650
PXS_{t-1}	0.16031	0.04047	0.04779	0.05265
$PWXG_{t}$	0.15870	0.03766	0.05877	0.03253
$(PG/PT_1)_{t-1}$	0.09629	-0.06098	-0.18501	0.23519
$(PC/PT_2)_{t-1}$	-0.32867	0.20430	0.17639	-0.19818
RL_{t-1}	-0.03519	0.37693	-0.05040	0.25415
RD_{t-1}	-0.13481	0.45482	-0.04475	0.25199
RIT_{t-1}	0.13471	-0.36881	0.13626	-0.27868

Principal Components (Factors)			
Orthogonal		Oblique	
Factor 1	Factor 2	Factor 1	Factor 2
-0.989172	1.151653	-1.485716	1.714027
-0.974698	1.123586	-1.457096	1.665716
-0.623782	0.761956	-1.436189	1.628937
-1.346957	2.031151	-1.064470	1.699497
-0.810993	1.473475	-1.228860	1.788167
-0.872512	1.175400	-0.982807	1.337163
-0.538089	0.323634	-0.779211	0.731107
-0.324936	-0.679786	-0.616557	0.083045
-0.212557	-0.931334	-0.491568	-0.151949
-0.201419	-0.946809	-0.357431	-0.288532
-0.224932	-0.960234	-0.128172	-0.532990
-0.313911	-0.882303	-0.002349	-0.656117
-0.296975	-0.880806	0.144051	-0.797027
-0.168810	-0.782368	0.252181	-0.760878
-0.022142	-0.892645	0.222826	-0.725603
-0.010385	-0.964289	0.346420	-0.901426
0.077263	-0.956730	0.441102	-0.970829
0.204117	-0.855360	0.527218	-0.951093
0.399383	-0.886383	0.693154	-1.097791
0.293533	-0.623867	1.027744	-1.330028
0.722848	0.270650	1.189050	-0.742594
1.549039	1.401783	1.208076	0.305673
1.838053	1.148635	1.842075	-0.347554
2.833558	0.409057	2.107909	-0.650612

APPENDIX 3

The following tables exhibit the root mean square percentage error (RMSPE) of the variables of the various estimated models for the: (i) 1959-1977 period (historical simulation for the sample used in the estimation), (ii) 1959-1982 which includes both the estimation and the forecasting period (1978-1982) and (iii) simulation, forecasting results and multipliers.

TABLE 1 RMSPE FOR 1959-1977

Variables	Orthogonal Factors		Oblique Factors	
	Simultaneous System	Block Recursive	Simultaneous System	Block Recursive
GNPM	4.93	4.28	4.77	5.31
GNPF	5.66	4.66	5.04	5.26
DY	5.35	5.31	4.09	5.61
TC	3.80	3.54	2.42	3.04
TFI	8.41	9.02	9.79	11.10
XG	14.52	13.17	10.85	12.77
X	11.07	10.59	9.10	10.10
MG	7.28	8.52	7.86	8.96
M	8.40	9.66	9.98	10.55
CPI	5.29	9.50	4.99	11.23
PGNPM	5.13	9.44	5.17	10.84
UN	37.67	66.05	26.90	39.72
RL	5.18	7.37	5.01	5.89
XV	14.31	19.48	11.19	17.02
MV	11.52	19.00	12.84	21.29

The variables included in the above and similar tables with the RMSPE results are:

1) real GNP at market prices (GNPM),
2) real GNP at factor cost (GNPF),
3) real disposable income (DY),
4) real total consumption (TC),
5) real total fixed investment (TFI),
6) exports of goods at constant prices (XG),
7) total exports of goods and services at constant prices (X),
8) imports of goods at constant prices (MG),
9) total imports of goods and services at constant prices (M),
10) the consumer price index (CPI),
11) the implicit deflator of the GNP at market prices (PGNPM),
12) unemployment (UN),
13) the interest rate on long term credits (RL),
14) the value of total exports of goods and services (XV),
15) the value of total imports of goods and services (MV).

TABLE 2 RMSPE FOR 1959 - 1981

Variables	Simultaneous System	
	Orthogonal Factors	Oblique Factors
GNPM	5.10	6.79
GNPF	5.93	7.41
DY	6.43	6.90
TC	3.89	3.45
TFI	9.91	10.58
XG	14.06	11.93
X	10.14	9.15
MG	8.23	8.96
M	10.49	12.18
CPI	16.11	13.50
PGNPM	13.96	12.50
UN	40.01	35.33
RL	5.85	6.77
XV	18.88	20.77
MV	18.07	20.12

TABLE 3 RMSPE FOR 1959-1977

Variables	Simultaneous System Estimated with only 2 Factors (First Set of Variables)	
	Orthogonal Factors	Oblique Factors
GNPM	10.78	9.63
GNPF	13.28	11.94
DY	11.87	12.18
TC	8.78	7.19
TFI	18.08	22.23
XG	23.48	23.69
X	21.79	19.41
MG	33.32	31.07
M	36.21	38.42
CPI	17.85	17.24
PGNPM	20.90	19.76
UN	30.48	28.52
RL	11.28	11.73
XV	31.51	28.13
MV	44.29	46.58

TABLE 4 Actual and Simulated Values from Orthogonal and Oblique Factors. Period 1959-1982

	In Billion drs at constant 1970 prices															Base Year 1970						In thousands		
Years	GNPM			TC			TFI			X			M			PGNPM			CPI			UN		
	Actual	ORFC	OBFC	Actual	ORFC	OBFC	Actual	ORFC	OBFC	Actual	ORFC	OBFC	Actual	ORFC	OBFC	Actual	ORFC	OBFC	Actual	ORFC	OBFC	Actual	ORFC	OBFC
1959	139.0	145.0	134.9	105.2	109.9	105.1	25.3	26.5	23.0	10.8	12.2	10.6	16.7	19.1	16.9	71.0	73.0	73.0	80.0	84.0	79.0	89.0	83.0	87.0
1960	145.5	134.7	139.4	108.7	107.7	109.5	29.1	23.0	24.4	10.8	11.0	10.0	19.1	17.9	18.6	74.0	71.0	76.0	82.0	83.0	88.0	87.0	107.0	113.0
1961	161.8	162.3	139.0	116.5	116.0	109.2	31.5	30.4	24.8	12.4	10.3	9.3	21.5	17.8	18.9	75.0	75.0	76.0	83.0	83.0	79.0	76.0	160.0	63.0
1962	164.7	170.9	161.7	121.8	126.8	123.0	34.1	36.4	34.3	13.6	12.7	11.5	23.7	26.4	22.7	78.0	79.0	79.0	83.0	86.0	85.0	75.0	78.0	63.0
1963	181.5	168.7	176.0	128.5	128.1	128.8	36.0	35.7	38.7	14.5	11.3	12.8	27.3	24.5	26.4	79.0	72.0	76.0	85.0	79.0	81.0	70.0	64.0	70.0
1964	196.6	198.0	197.2	138.9	142.6	141.1	43.4	41.9	43.1	14.8	15.1	16.2	31.5	26.6	26.3	82.0	75.0	78.0	86.0	80.0	86.0	65.0	104.0	77.0
1965	214.9	228.1	205.9	149.8	160.1	149.7	49.0	50.4	47.0	16.7	18.5	17.0	38.1	38.6	33.3	85.0	86.0	85.0	89.0	90.0	85.0	64.0	91.0	57.0
1966	228.0	235.5	229.0	161.0	166.3	162.8	50.6	54.4	54.8	22.4	20.2	20.3	37.9	39.4	39.2	89.0	85.0	88.0	93.0	88.0	90.0	65.0	68.0	47.0
1967	240.8	262.1	257.3	170.3	180.5	177.8	49.8	61.4	61.2	23.5	23.8	23.5	40.7	44.5	43.2	92.0	86.0	85.0	94.0	87.0	92.0	84.0	64.0	45.0
1968	257.2	270.1	270.1	181.5	188.1	183.9	60.4	64.5	64.2	23.3	24.9	23.3	44.9	47.0	42.4	93.0	86.0	80.0	95.0	89.0	93.0	74.0	69.0	64.0
1969	282.2	303.0	289.4	193.3	204.8	196.1	71.7	75.0	69.0	26.7	29.4	26.3	51.8	55.5	44.1	96.0	95.0	89.0	95.0	94.0	92.0	67.0	46.0	48.0
1970	304.4	311.4	307.5	210.0	214.7	211.4	70.7	77.5	75.8	30.0	33.5	29.7	55.0	60.3	53.9	100.0	100.0	103.0	100.0	100.0	99.0	49.0	40.0	31.0
1971	327.7	323.5	332.4	223.9	222.5	224.0	80.6	80.2	82.3	33.5	34.8	32.9	59.2	62.1	60.0	103.0	103.0	106.0	103.0	103.0	104.0	30.0	43.0	34.0
1972	356.9	342.4	357.0	240.0	231.0	237.0	93.0	84.6	87.4	41.2	37.7	38.1	68.3	65.3	65.0	109.0	108.0	109.0	107.0	107.0	109.0	24.0	40.0	34.0
1973	378.9	358.8	355.9	259.3	243.7	246.3	100.1	91.4	90.2	50.8	42.3	45.0	90.4	74.5	74.0	129.0	118.0	120.0	124.0	114.0	109.0	21.0	28.0	25.0
1974	369.3	374.4	361.9	257.6	250.9	250.0	74.5	74.6	70.9	48.2	43.7	44.4	75.1	71.6	66.2	158.0	153.0	156.0	158.0	151.0	154.0	27.0	38.0	20.0
1975	390.0	402.3	403.3	274.1	269.0	274.7	74.7	76.5	76.4	52.8	51.5	51.8	79.9	77.2	71.7	177.0	171.0	176.0	179.0	170.0	163.0	35.0	44.0	21.0
1976	415.5	423.6	428.1	292.1	284.2	286.1	79.7	78.9	79.7	61.1	58.2	57.8	84.9	78.4	71.2	205.0	189.0	195.0	202.0	185.0	197.0	28.0	42.0	23.0
1977	431.2	449.1	454.4	307.5	302.0	308.5	85.9	89.0	87.7	62.5	60.7	64.1	91.5	85.1	83.0	231.0	208.0	215.0	228.0	202.0	208.0	28.0	34.0	17.0
1978	458.7	458.6	470.6	324.8	321.3	331.8	91.1	102.3	102.7	75.1	63.6	67.5	98.3	93.7	95.3	260.0	222.0	225.0	257.0	219.0	209.0	31.0	32.0	18.0
1979	476.0	521.3	543.1	332.9	348.1	359.9	99.0	118.9	116.9	81.0	78.0	76.4	104.4	111.1	96.7	309.0	238.0	238.0	306.0	227.0	211.0	32.0	17.0	12.0
1980	483.0	517.7	569.7	333.5	349.7	362.3	89.8	102.3	110.1	84.8	85.7	73.5	97.0	97.4	79.6	366.0	234.0	238.0	382.0	222.0	239.0	37.0	21.0	14.0
1981	479.4	504.3	559.7	335.9	356.6	353.4	82.0	78.6	94.3	87.1	96.7	75.5	101.9	75.4	65.1	439.0	248.0	281.0	476.0	226.0	327.0	43.0	42.0	10.0
1982	474.5	466.9	516.4	353.8	350.6	346.5	81.2	51.7	61.1	74.4	92.8	71.4	104.8	63.9	56.8	551.0	272.0	308.0	576.0	242.0	350.0	50.0	61.0	15.0

ORFC = forecasts from the simultaneous system with orthogonal factors

OBFC = forecasts from the simultaneous system with oblique factors

TABLE 5 FIGURES OF MAPE FOR TWO PERIODS

Variables	Mean Absolute Percent Error (MAPE)			
	Simultaneous System with Orthogonal Factors		Simultaneous System with Oblique Factors	
	1959-1977	1959-1981	1959-1977	1959-1981
GNPM	4.14	4.20	3.57	4.95
GNPF	4.56	4.68	4.03	5.43
TC	3.18	3.28	1.66	2.28
TFI	6.36	7.51	7.08	8.21
XG	9.26	9.95	6.88	8.12
X	8.48	8.13	6.59	6.88
MG	7.26	7.00	6.33	6.69
M	8.47	8.32	8.18	8.94
DY	4.46	4.97	3.23	4.68
CPI	4.45	9.44	3.85	8.32
PGNPM	4.22	8.42	3.88	7.66
UN	32.53	31.72	23.35	29.81
RL	4.31	4.85	3.87	4.77
XV	11.49	17.29	9.10	15.16
MV	10.86	13.65	10.62	14.62

TABLE 6 FIGURES OF MPE FOR TWO PERIODS

Variables	Mean Percent Error (MPE)			
	Simultaneous system with orthogonal factors		Simultaneous systems with oblique factors	
	1959-1977	1959-1981	1959-1977	1959-1981
GNPM	1.49	2.11	-0.48	1.75
GNPF	0.91	1.87	-1.14	1.45
TC	0.97	1.39	-0.25	0.70
TFI	1.29	3.02	-0.85	1.91
XG	0.93	1.79	-4.15	-2.23
X	-2.07	-2.37	-5.07	-5.57
MG	-1.08	-0.82	-5.37	-5.51
M	-1.40	-2.18	-6.87	-7.94
DY	2.09	2.34	0.96	2.92
CPI	-3.23	-8.44	-2.50	-7.22
PGNPM	-3.69	-8.00	-2.31	-6.38
UN	22.42	13.75	-10.73	-19.37
RL	2.35	1.50	0.03	-1.01
XV	-4.52	-10.78	-8.13	-14.25
MV	-0.54	-5.60	-9.28	-13.58

TABLE 7 FIGURES OF MAE FOR TWO PERIODS

Variables	Mean Absolute Error (MAE)			
	Simultaneous system with Orthogonal factors		Simultaneous systems with Oblique factors	
	1959-1977	1959-1981	1959-1977	1959-1981
GNPM	10.8	13.0	9.3	17.6
GNPF	11.1	13.4	8.9	16.8
TC	6.1	7.1	3.1	5.6
TFI	3.5	5.0	3.7	5.3
XG	1.4	2.2	1.0	2.1
X	2.3	2.7	1.7	2.5
MG	2.8	3.3	3.0	3.7
M	4.0	5.0	4.7	6.3
DY	10.0	13.4	7.6	14.0
CPI	6.0	28.0	5.0	23.0
PGNPM	5.0	23.0	4.0	21.0
UN	17.0	15.0	12.0	14.0
RL	0.3	0.5	0.3	0.6
XV	5.2	26.8	3.9	26.2
MV	7.4	29.6	9.9	36.5

TABLE 8

Variables	Mean Values	
	1959-1977	1959-1981
GNPM	273.0	301.9
GNPF	241.3	267.1
TC	191.6	210.0
TFI	60.0	64.6
XG	19.6	24.4
X	30.0	37.6
MG	42.6	47.3
M	50.4	57.1
DY	222.4	244.0
CPI	114.0	138.0
PGNPM	112.0	135.0
UN	56.0	52.0
RL	8.1	8.9
XV	44.8	73.9
MV	75.3	108.2

In the above two tables the variables CPI and PGNPM are price indices with base year 1970. The interest rate (RL) is in percentage, and unemployment (UN) is measured in thousands. The other variables are expressed in billion drs. (Those in real terms are expressed in 1970 prices).

TABLE 9 ACTUAL AND FORECAST VALUES PERIOD 1978-1982

Years	In billion drs at constant 1970 prices													
	GNPM			TC			TFI			X		M		
	Actual	SIMA[a]	SIMB[b]	Actual	SIMA	SIMB	Actual	SIMA	SIMB	Actual	SIMA	SIMB	Actual	SIMA
1978	458.7	437.4	437.4	324.8	323.5	323.5	91.1	98.0	98.0	75.1	65.4	65.4	98.3	100.0
1979	476.0	519.5	485.1	332.9	355.6	346.0	99.0	121.0	101.6	81.0	80.1	77.6	104.4	124.0
1980	483.0	524.9	430.0	333.5	352.0	325.1	89.8	98.5	78.1	84.8	83.4	77.7	97.0	82.3
1981	479.4	529.5	331.7	335.9	369.3	313.4	82.0	82.4	30.3	87.1	94.4	85.7	101.9	79.4
1982	474.5	474.4	276.4	353.8	361.1	319.0	81.2	53.5	7.8	74.4	94.6	80.9	104.8	76.2

Years	M	Base Year 1970						In thousands		
		PGNPM			CPI			UN		
	SIMB	Actual	SIMA	SIMB	Actual	SIMA	SIMB	Actual	SIMA	SIMB
	100.0	260.0	241.0	241.0	257.0	243.0	243.0	31.0	22.0	22.0
	109.1	309.0	240.0	301.0	306.0	226.0	296.0	32.0	12.0	17.0
	88.1	366.0	221.0	331.0	382.0	209.0	339.0	37.0	38.0	25.0
	62.8	439.0	254.0	400.0	476.0	228.0	429.0	43.0	49.0	61.0
	54.5	551.0	280.0	496.0	576.0	248.0	542.0	50.0	44.0	117.0

a. SIMA = Forecast values starting from 1978 and using for the lagged endogenous variables the values generated by the model.

b. SIMB = Forecast values starting from 1978 of one year ahead forecasts, that is the actual values of the lagged endogenous variables are used.

Both series of estimates were derived by using the preferred simultaneous model with four orthogonal principle components.

TABLE 10 FIGURES OF RMSPE

Variables	Root Mean Square Percent Error (RMSPE)			
	SIM A*		SIM B*	
	1978-1980	1978-1981	1978-1980	1978-1981
GNPM	7.76	8.52	6.96	16.54
GNPF	9.60	9.89	8.31	19.33
TC	5.09	6.65	2.71	4.09
TFI	14.68	12.72	8.83	32.47
XG	7.78	17.81	7.92	10.99
X	7.55	7.75	9.21	8.02
MG	5.94	5.91	3.62	13.12
M	13.98	16.37	6.00	19.87
DY	11.92	13.75	7.39	12.20
CPI	30.26	36.92	7.44	8.09
PGNPM	26.68	31.24	7.08	7.58
UN	39.99	35.45	37.17	38.34
RL	5.26	7.40	13.46	16.30
XV	31.13	33.76	22.08	20.07
MV	29.08	33.53	19.41	27.18

* SIM A and SIM B are as in Table 9[a,b]

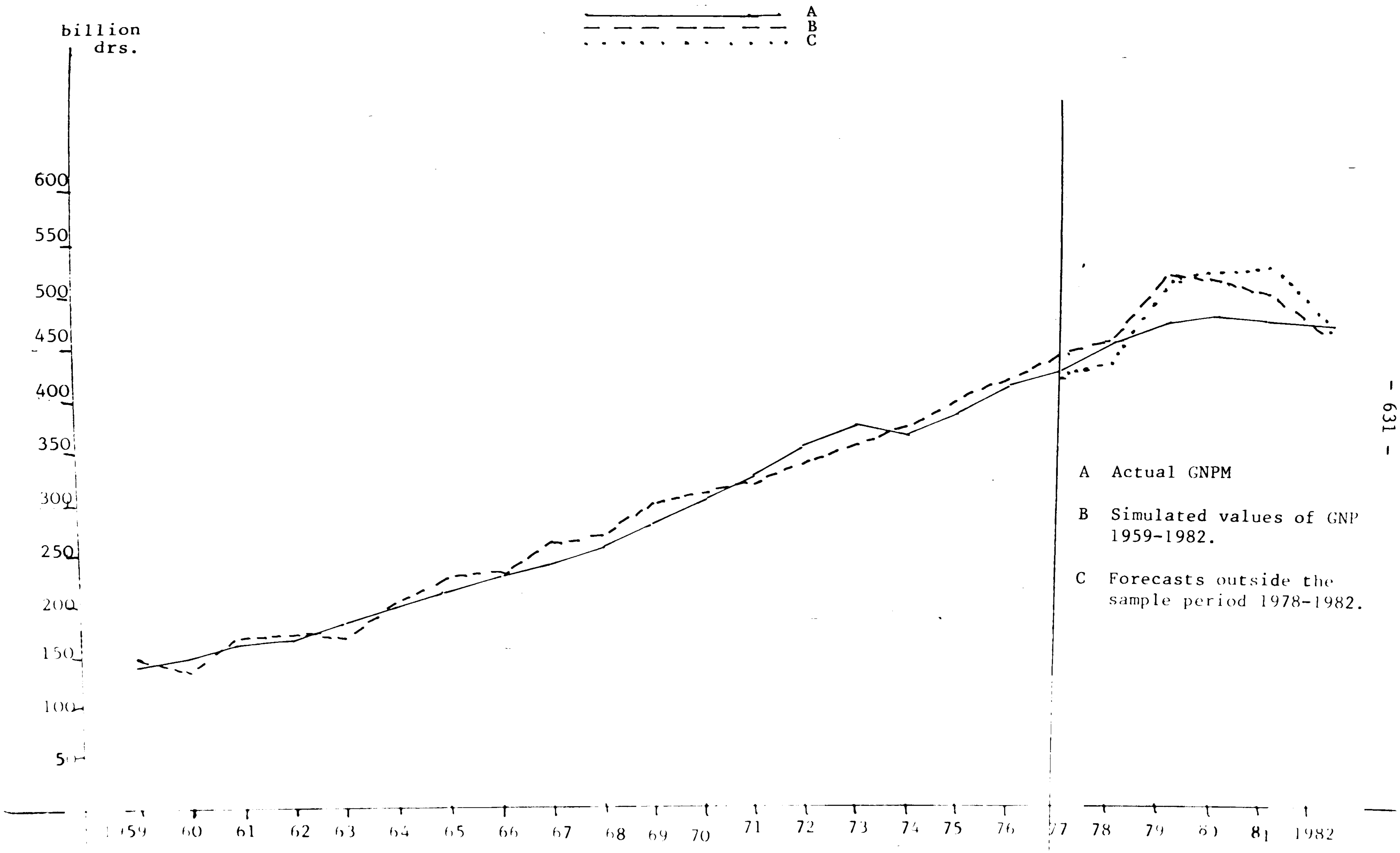
TABLE 11 FIGURES OF MAE

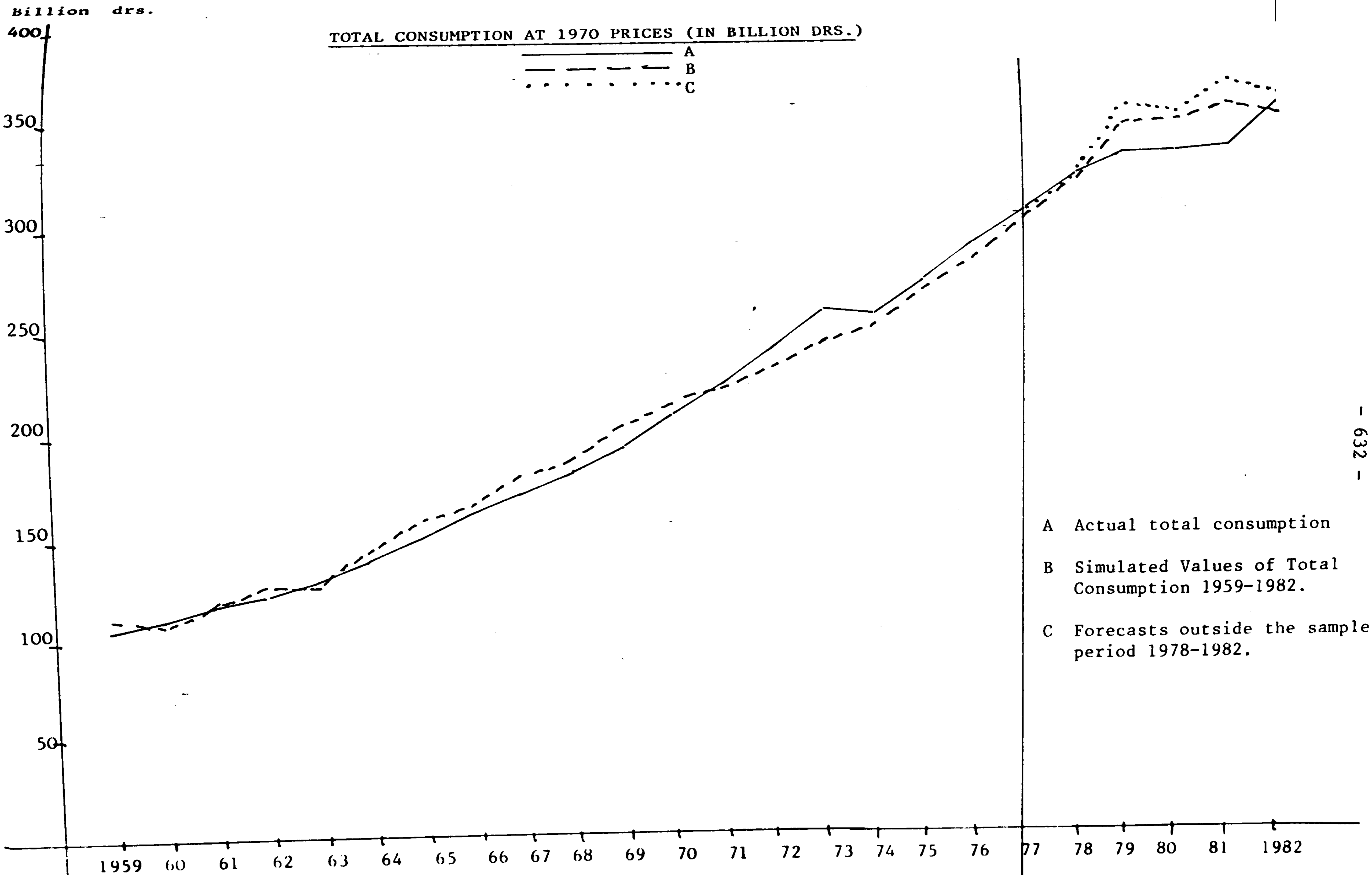
Variables	Mean Absolute Error (MAE)			
	SIM A*		SIM B*	
	1978-1980	1978-1981	1978-1980	1978-1981
GNPM	35.6	39.3	27.7	57.7
GNPF	39.1	41.0	30.1	62.1
TC	14.2	19.0	7.6	11.3
TFI	12.6	9.5	7.1	18.2
XG	3.3	7.1	3.5	5.1
X	4.0	4.8	6.7	5.4
MG	3.9	4.1	2.5	6.9
M	12.0	14.6	5.1	13.6
DY	37.5	44.2	23.7	36.1
CPI	88.7	128.4	22.2	28.3
PGNPM	78.0	104.6	20.8	25.4
UN	10.1	9.2	12.0	13.5
RL	0.7	1.0	1.7	2.3
XV	84.5	105.5	55.0	53.9
MV	94.2	130.3	63.4	105.0

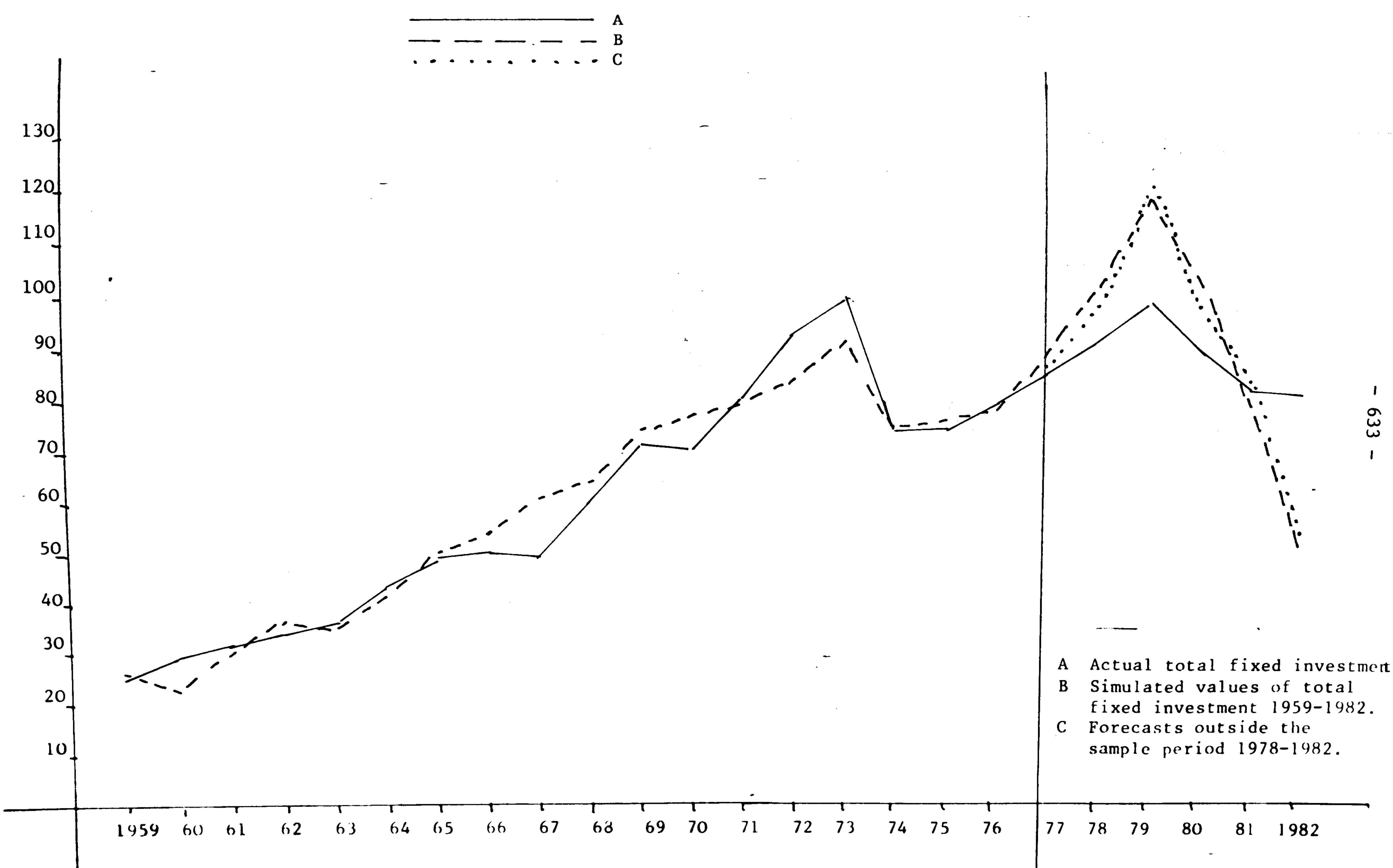
* SIM A and SIM B are as in Table 9[a,b].

In the above table CPI and PGNPM are price indices with base year 1970. The interest rate (RL) is in percentages, and Unemployment (UN) in thousands. The other variables are expressed in billion drs (those in real terms are expressed in 1970 prices).

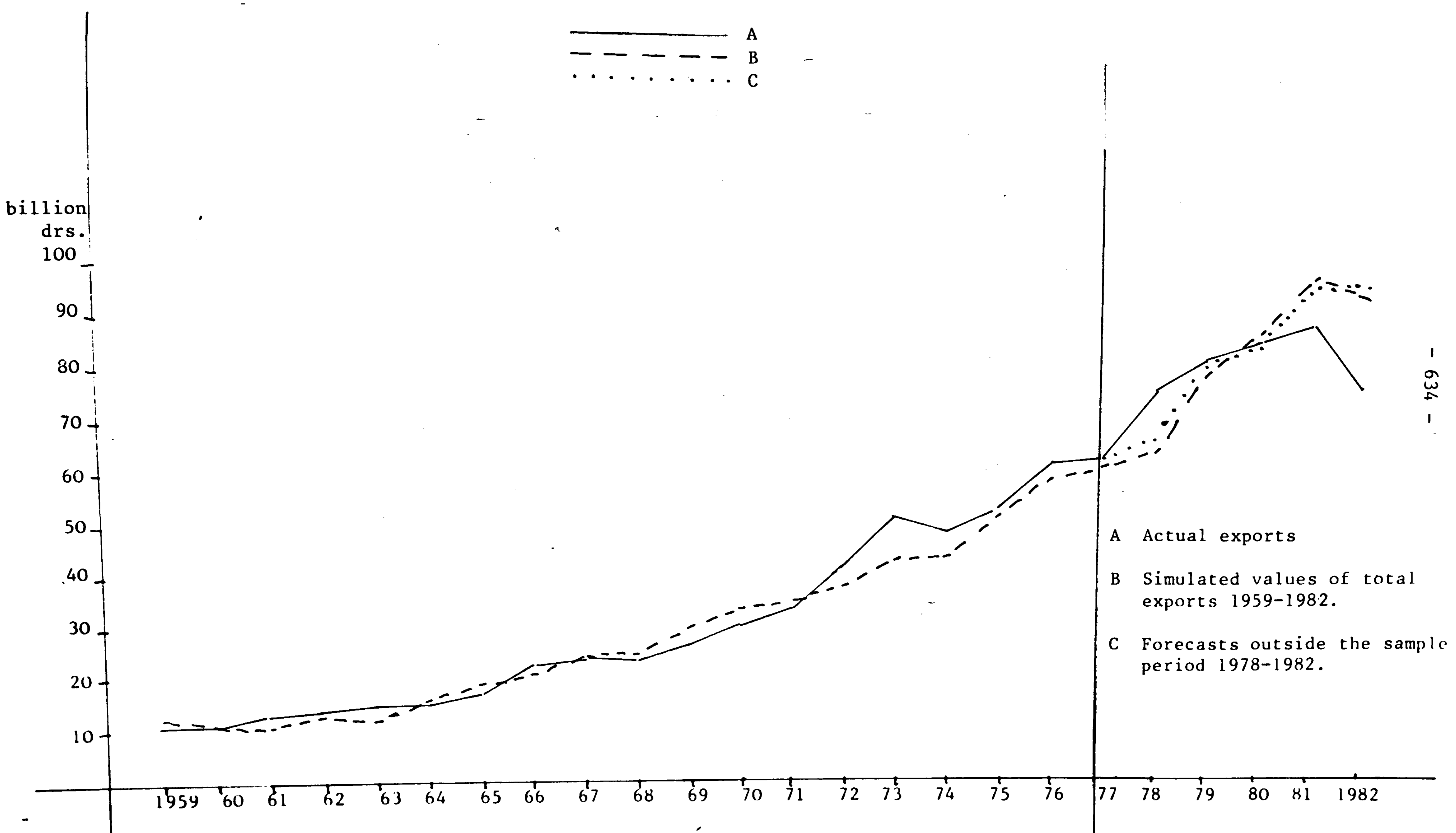
GNPM AT 1970 PRICES (IN BILLION DRS.)



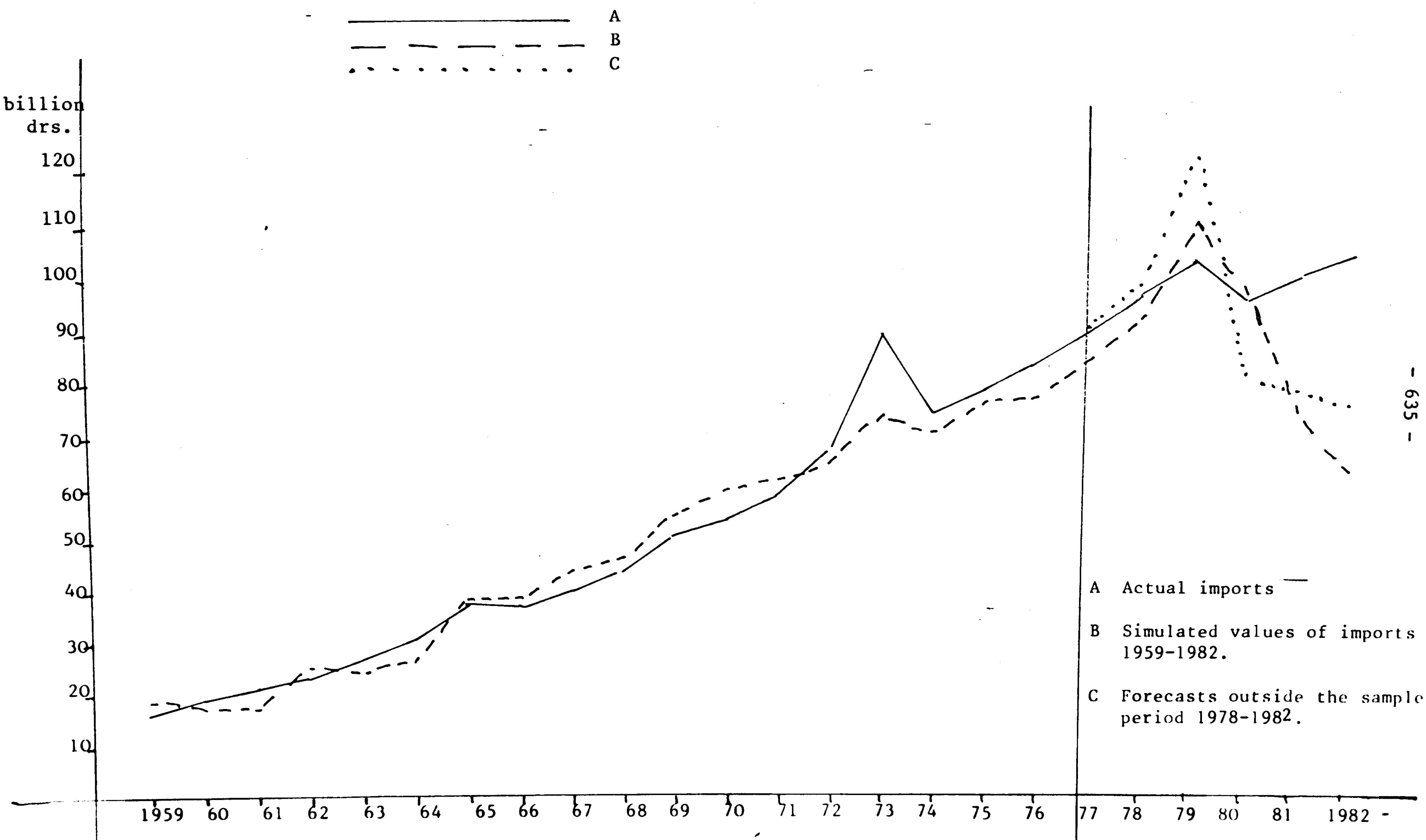

Billion drs.
TOTAL CONSUMPTION AT 1970 PRICES (IN BILLION DRS.)
A
B
C
400
350
300
250
200
150
100
50
1959 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 1982
A Actual total consumption
B Simulated Values of Total Consumption 1959-1982.
C Forecasts outside the sample period 1978-1982.


A
B
C
130
120
110
100
90
80
70
60
50
40
30
20
10
1959 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 1982
A Actual total fixed investment
B Simulated values of total fixed investment 1959-1982.
C Forecasts outside the sample period 1978-1982.

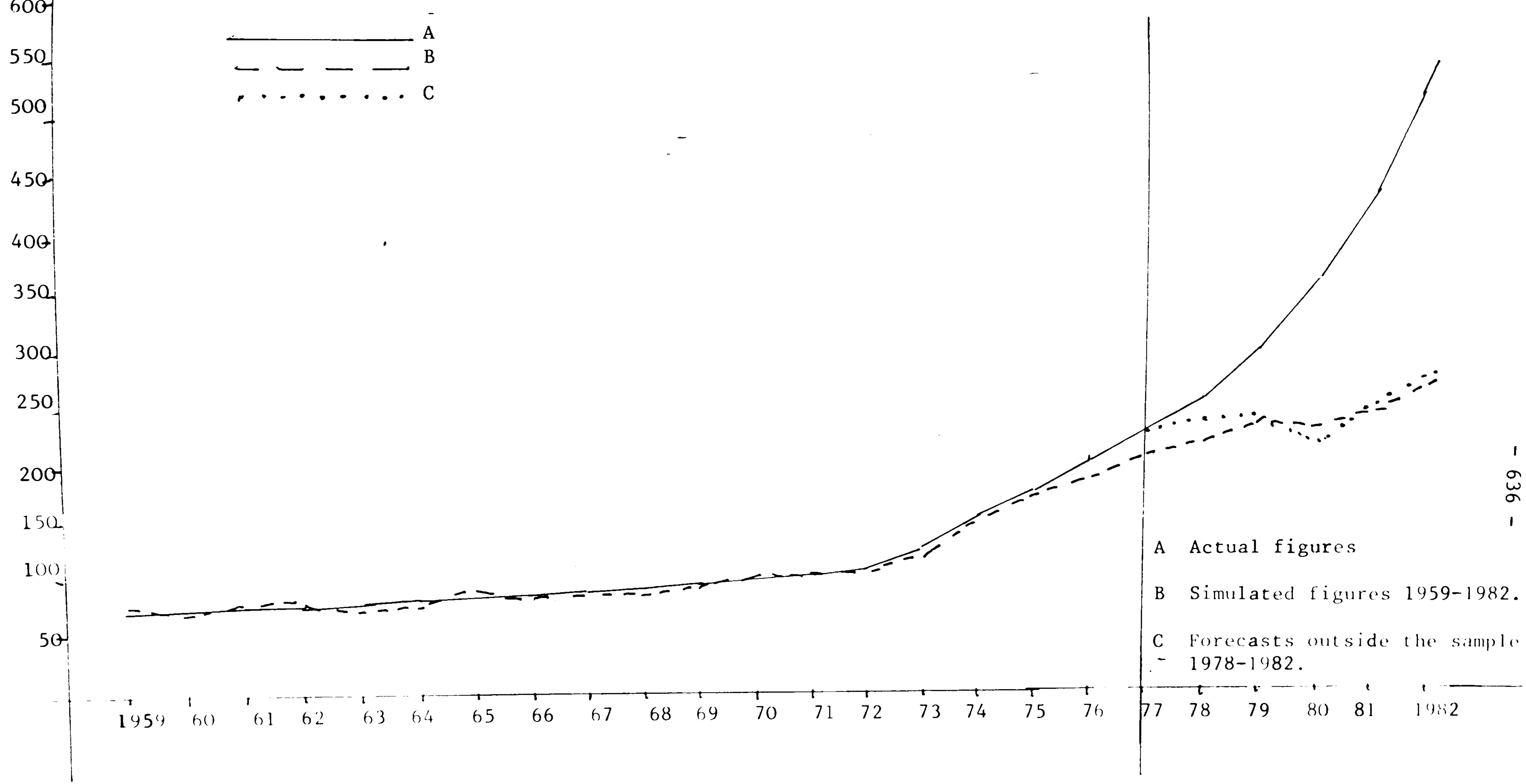
TOTAL EXPORTS AT 1970 PRICES (IN BILLION DRS.)



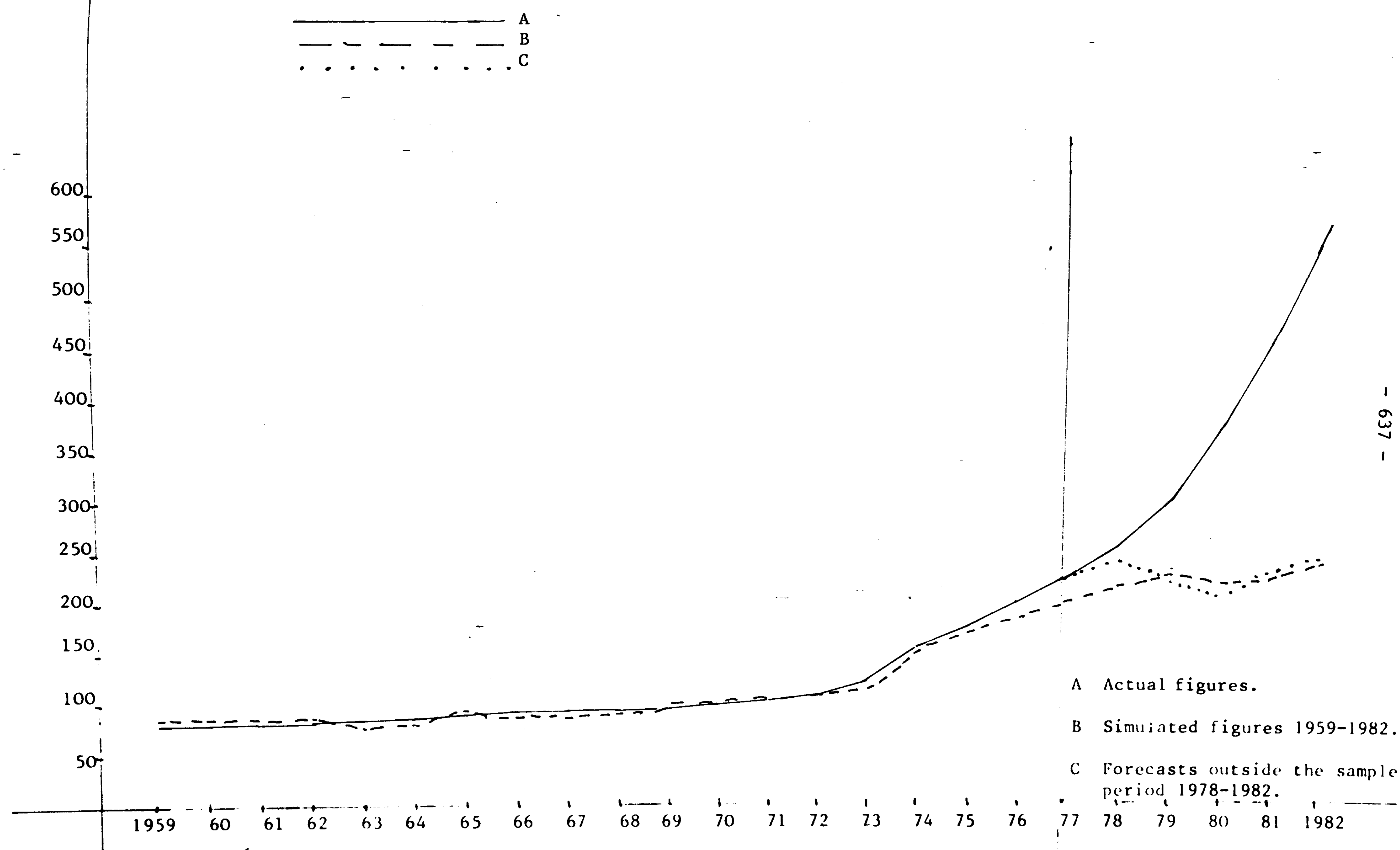
TOTAL IMPORTS AT 1970 PRICES (IN BILLION DRS.)



IMPLICIT DEFLATOR OF GNP AT MARKET PRICES (BASE YEAR 1970:100)



CONSUMER PRICE INDEX (CPI) BASE YEAR 1970:100



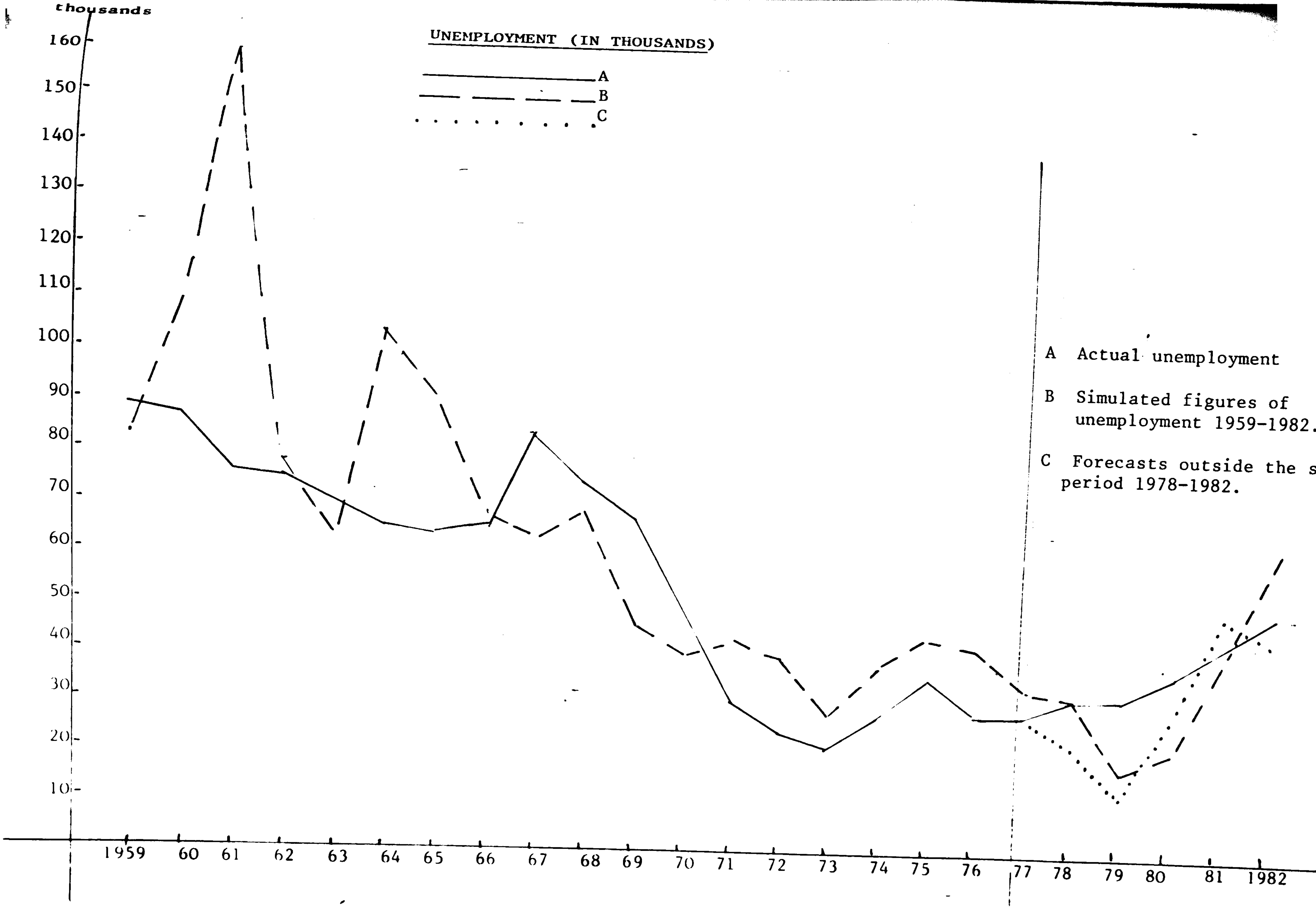

thousands
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
UNEMPLOYMENT (IN THOUSANDS)
A
B
C
A Actual unemployment
B Simulated figures of unemployment 1959-1982.
C Forecasts outside the sample period 1978-1982.
1959
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
1982

TABLE 12 DYNAMIC MULTIPLIERS OF 1 BILLION DRS. INCREASE IN 1969 OF GOVERNMENT'S CURRENT EXPENDITURE ON GOODS AND SERVICES (AT 1970 PRICES). SIMULATION FROM 1969 TO 1980.

Year	GNPM	TC	TFI	M	PGNPM	CPI	X	II
1	8.703	2.994	1.341	2.009	2.89	2.01	1.337	3.894
2	-4.688	-1.218	0.069	-0.957	0.20	1.27	-0.527	-1.907
3	0.249	-0.136	0.147	-0.420	-0.21	0.12	-0.296	-0.134
4	0.960	0.270	0.340	0.194	0.26	0.07	0.090	0.397
5	-0.126	-0.040	-0.009	0.006	-0.18	-0.18	0.085	-0.046
6	0.084	0.021	0.049	0.001	-0.22	-0.24	0.060	-0.007
7	0.319	0.122	0.109	0.099	-0.04	-0.08	0.066	0.101
8	0.275	0.103	0.093	0.078	0.03	0.00	0.058	0.086
9	0.106	0.041	0.053	0.043	-0.03	-0.05	0.048	0.016
10	-0.073	-0.024	0.005	0.001	-0.15	-0.14	0.029	-0.059
11	-0.058	-0.023	0.007	0.011	-0.13	-0.14	0.012	-0.028
12	0.092	0.040	0.031	0.032	-0.20	0.01	0.009	0.018

TABLE 13 CUMULATIVE EFFECT OF MULTIPLIERS IN THE ABOVE TABLE 12 ON GNPM, TC, TFI, M, X and II.

Year	GNPM	TC	TFI	M	X	II
1	8.703	2.994	1.341	2.009	1.337	3.894
2	4.015	1.776	1.410	1.052	0.810	1.987
3	4.264	1.640	1.557	0.632	0.514	1.853
4	5.224	1.910	1.897	0.826	0.604	2.250
5	5.098	1.870	1.888	0.832	0.689	2.204
6	5.182	1.891	1.937	0.833	0.749	2.197
7	5.501	2.013	2.046	0.932	0.815	2.298
8	5.776	2.116	2.139	1.010	0.873	2.384
9	5.882	2.157	2.192	1.053	0.921	2.400
10	5.809	2.133	2.197	1.054	0.950	2.341
11	5.751	2.110	2.204	1.065	0.962	2.313
12	5.843	2.150	2.235	1.097	0.971	2.331

TABLE 14 DYNAMIC MULTIPLIERS OF 10% INCREASE IN 1969 IN THE EXCHANGE RATE (ER), NORMALISED (DIVIDING BY ΔER). SIMULATION FROM 1969 TO 1980

Year	GNPM	TC	TFI	X	M	PGNPM	CPI	II
1	-3.348	-1.239	-2.630	0.940	-1.753	0.10	-0.15	-1.617
2	2.206	0.348	0.606	-0.764	0.353	2.06	1.33	1.668
3	-0.386	0.067	-0.208	0.115	0.317	1.01	1.18	-0.026
4	-1.508	-0.558	-0.362	-0.040	-0.508	-0.56	-0.35	-0.823
5	0.579	-0.014	0.070	0.009	-0.608	-0.50	-0.51	-0.095
6	0.782	0.287	0.211	0.083	0.198	0.09	0.01	-0.015
7	0.094	0.036	0.058	0.098	0.021	-0.13	-0.13	-0.037
8	-0.125	-0.041	0.012	0.086	0.004	-0.34	-0.32	-0.126
9	-0.138	-0.044	-0.009	0.069	-0.016	-0.39	-0.37	-0.127
10	-0.260	-0.084	-0.046	0.055	-0.045	-0.43	-0.38	-0.190
11	-0.181	-0.050	-0.034	0.041	-0.031	-0.29	-0.25	-0.153
12	0.058	0.031	0.053	0.063	0.057	-0.02	-0.03	-0.011

TABLE 15 CUMULATIVE EFFECT OF MULTIPLIERS IN THE ABOVE TABLE 14 IN GNPM, TC, TFI, X, M AND II

Year	GNPM	TC	TFI	X	M	II
1	-3.348	-1.239	-2.630	0.940	-1.753	-1.617
2	-1.142	-0.891	-2.024	0.176	-1.400	0.051
3	-1.548	-0.824	-2.232	0.291	-1.083	0.025
4	-3.036	-1.382	-2.594	0.251	-1.591	-0.798
5	-2.457	-1.396	-2.524	0.260	-2.199	-0.893
6	-1.675	-1.109	-2.313	0.343	-2.001	-0.908
7	-1.581	-1.073	-2.255	0.441	-1.980	-0.945
8	-1.706	-1.114	-2.243	0.527	-1.984	-1.071
9	-1.844	-1.130	-2.252	0.596	-2.0C	-1.198
10	-2.104	-1.198	-2.298	0.651	-2.045	-1.388
11	-2.285	-1.248	-2.332	0.692	-2.076	-1.541
12	-2.227	-1.233	-2.279	0.755	-2.019	-1.552

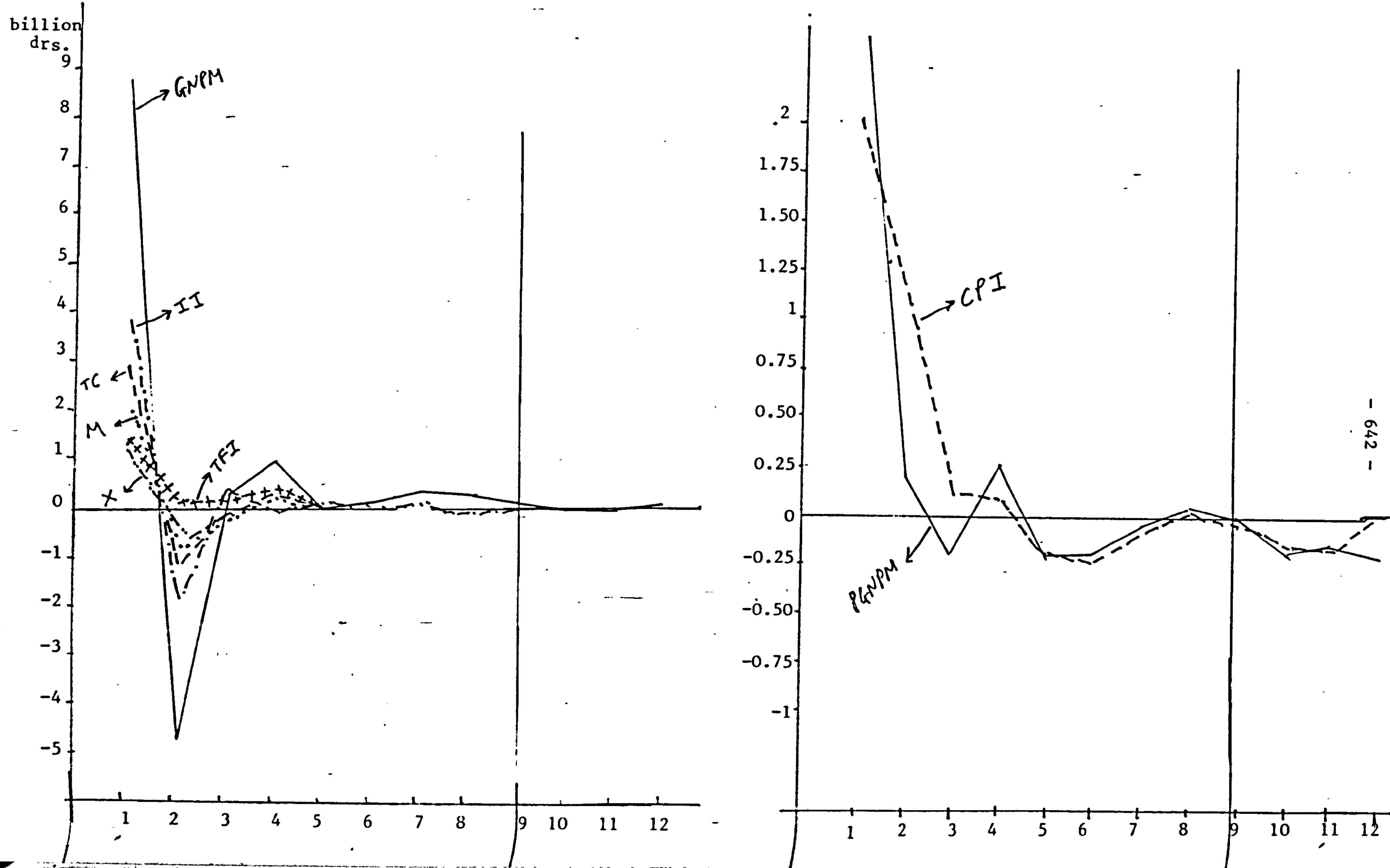
TABLE 16 DYNAMIC MULTIPLIERS OF 1 PERCENTAGE INCREASE IN THE BANK OF GREECE DISCOUNT RATE IN 1969. SIMULATION FROM 1969 TO 1980.

Year	GNPM	TC	TFI	X	M	PGNPM	CPI	II
1	4.898	2.709	1.571	0.591	1.972	2.72	1.49	1.694
2	-4.443	-0.633	-1.910	0.273	-0.557	-0.08	1.54	-2.583
3	1.243	0.052	0.579	-0.316	-0.330	0.46	0.14	0.236
4	0.945	0.269	0.349	0.123	0.276	0.30	0.07	0.485
5	-0.499	-0.185	-0.136	0.034	-0.118	-0.32	-0.29	-0.171
6	0.015	-0.028	-0.001	-0.024	-0.045	-0.23	-0.26	0.031
7	0.230	0.082	0.050	-0.011	0.068	0.02	-0.03	0.140
8	0.137	0.046	0.034	-0.013	0.040	0.07	0.04	0.089
9	-0.007	-0.009	0.008	-0.018	0.008	-0.01	-0.03	0.017
10	-0.127	-0.061	-0.026	-0.044	-0.037	-0.14	-0.14	-0.039
11	-0.064	-0.034	-0.006	-0.054	-0.001	-0.10	-0.11	0.007
12	0.098	0.031	0.022	-0.050	0.016	0.06	0.04	0.053

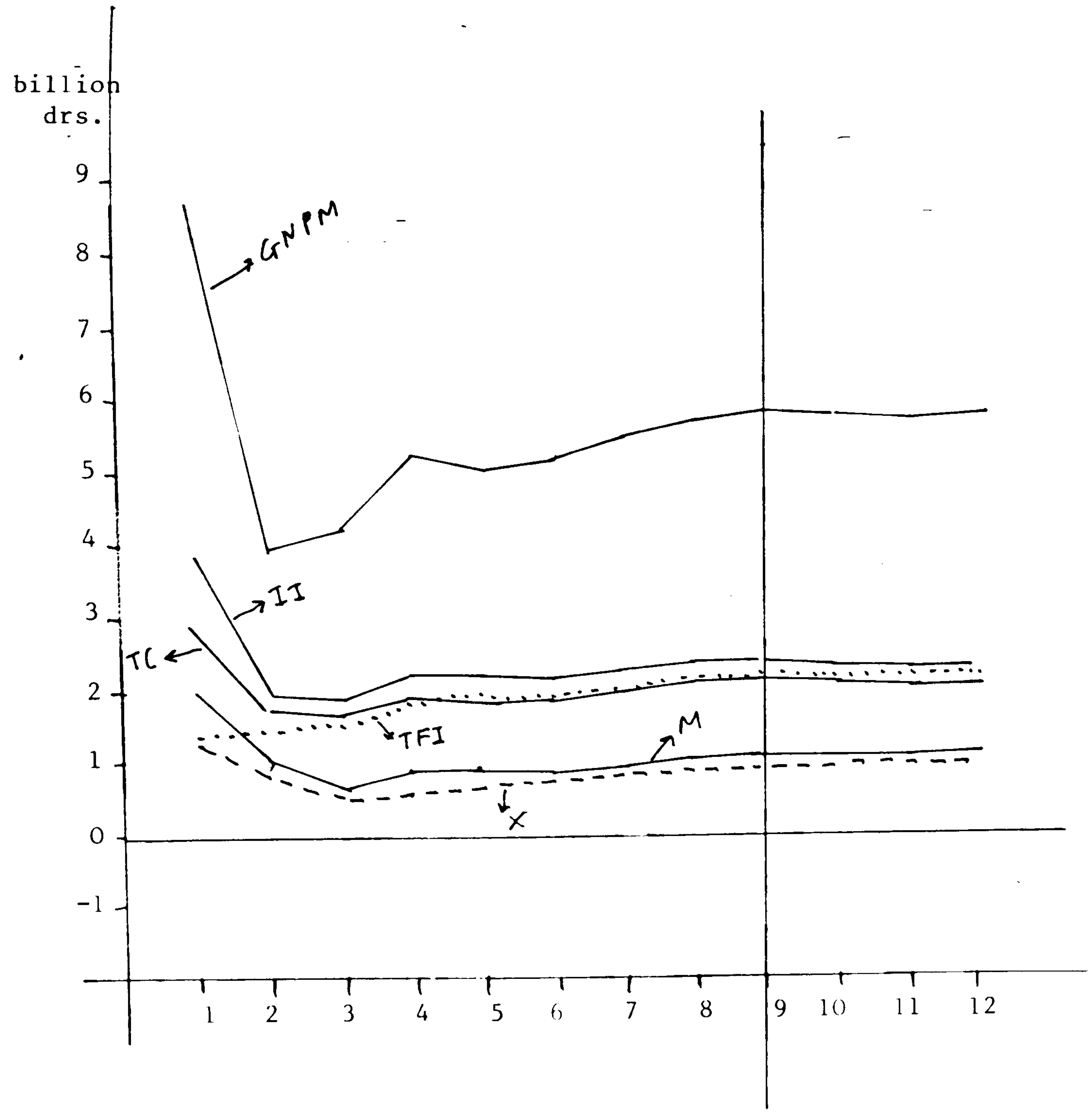
TABLE 17 CUMULATIVE EFFECT OF MULTIPLIERS IN THE ABOVE TABLE16. ON GNPM, TC, TFI, X, M AND I_I

Year	GNPM	TC	TFI	X	M	II
1	4.898	2.709	1.571	0.591	1.972	1.694
2	0.455	2.076	-0.339	0.864	1.415	-0.889
3	1.698	2.128	0.240	0.548	1.085	-0.603
4	2.643	2.397	0.589	0.671	1.361	-0.168
5	2.144	2.212	0.459	0.705	1.243	-0.339
6	2.159	2.184	0.452	0.681	1.198	-0.308
7	2.389	2.266	0.502	0.670	1.266	-0.168
8	2.526	2.312	0.536	0.657	1.306	-0.079
9	2.519	2.303	0.544	0.639	1.314	-0.062
10	2.392	2.242	0.518	0.595	1.277	-0.101
11	2.328	2.208	0.512	0.541	1.276	-0.094
12	2.426	2.239	0.534	0.491	1.293	-0.041

INCREASE IN 1969 OF GOVERNMENT'S REAL EXPENDITURE ON GOODS AND SERVICES (GCE) BY 1 BILLION DRS.

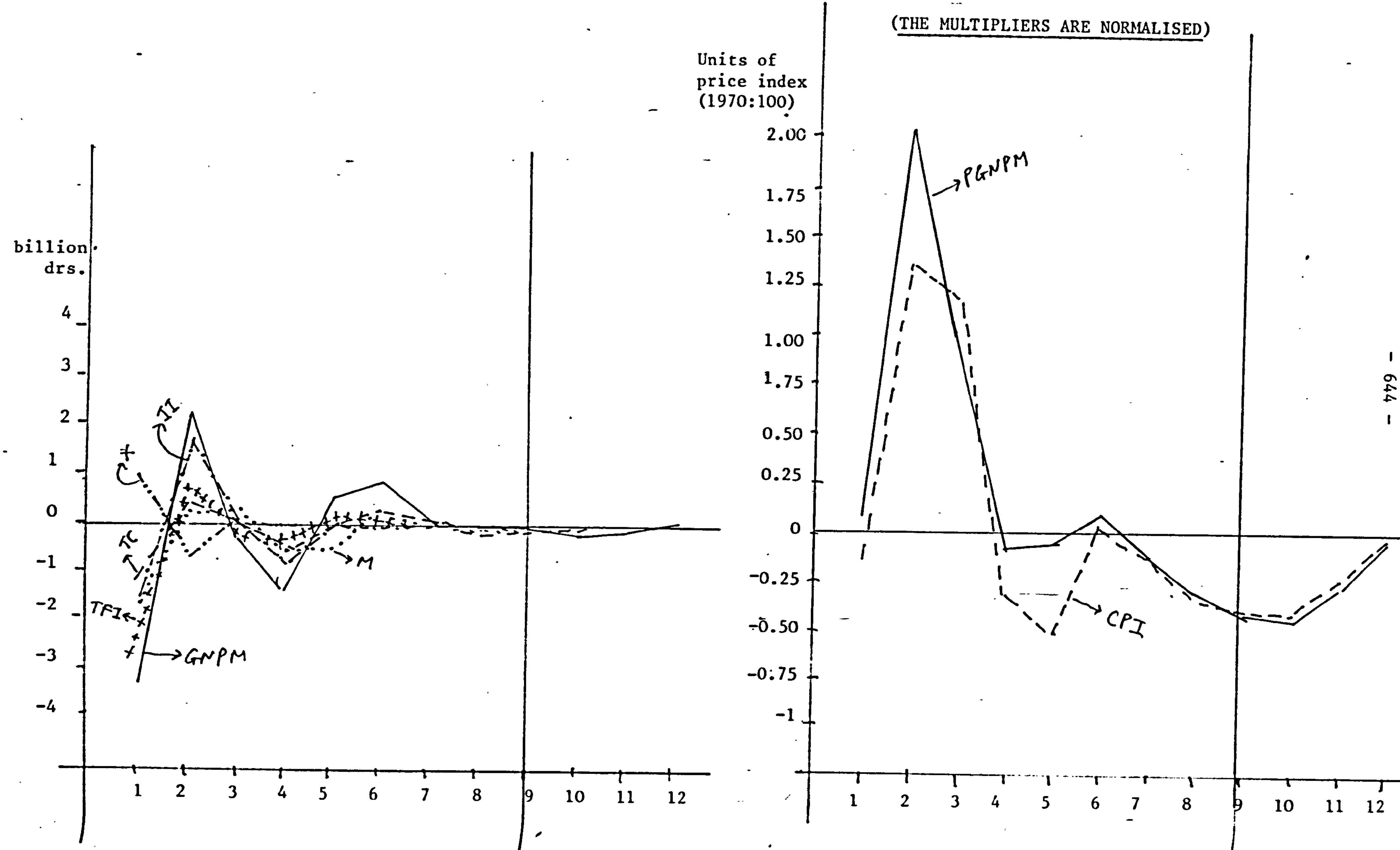


CUMULATIVE EFFECT OF ONE BILLION INCREASE IN GOVERNMENT'S EXPENDITURE ON GOODS AND SERVICES (GCE)

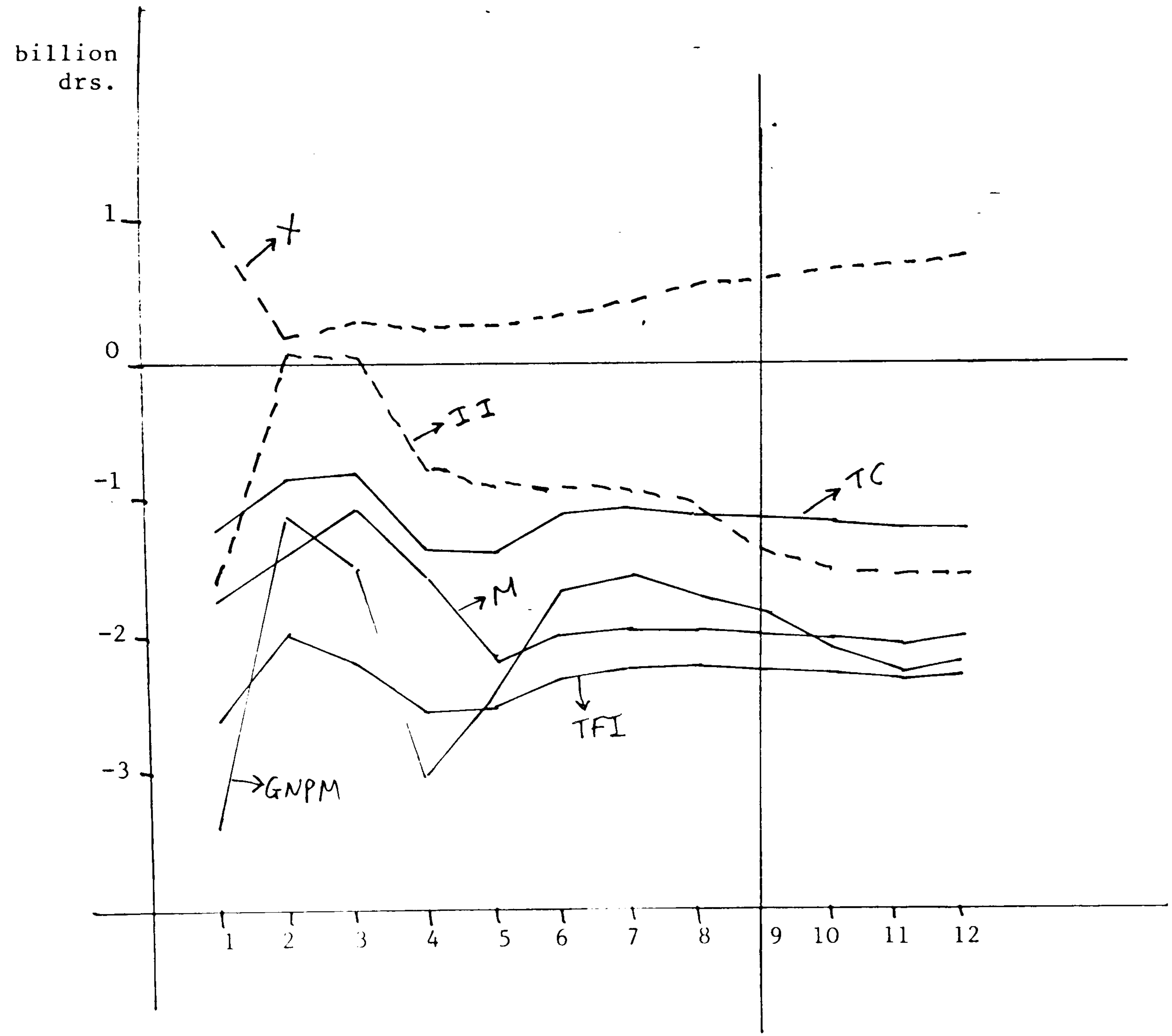


INCREASE IN 1969 OF EXCHANGE RATE FROM 30 DRS. TO 33 PER U.S.A. $ (10% DEPRECIATION)

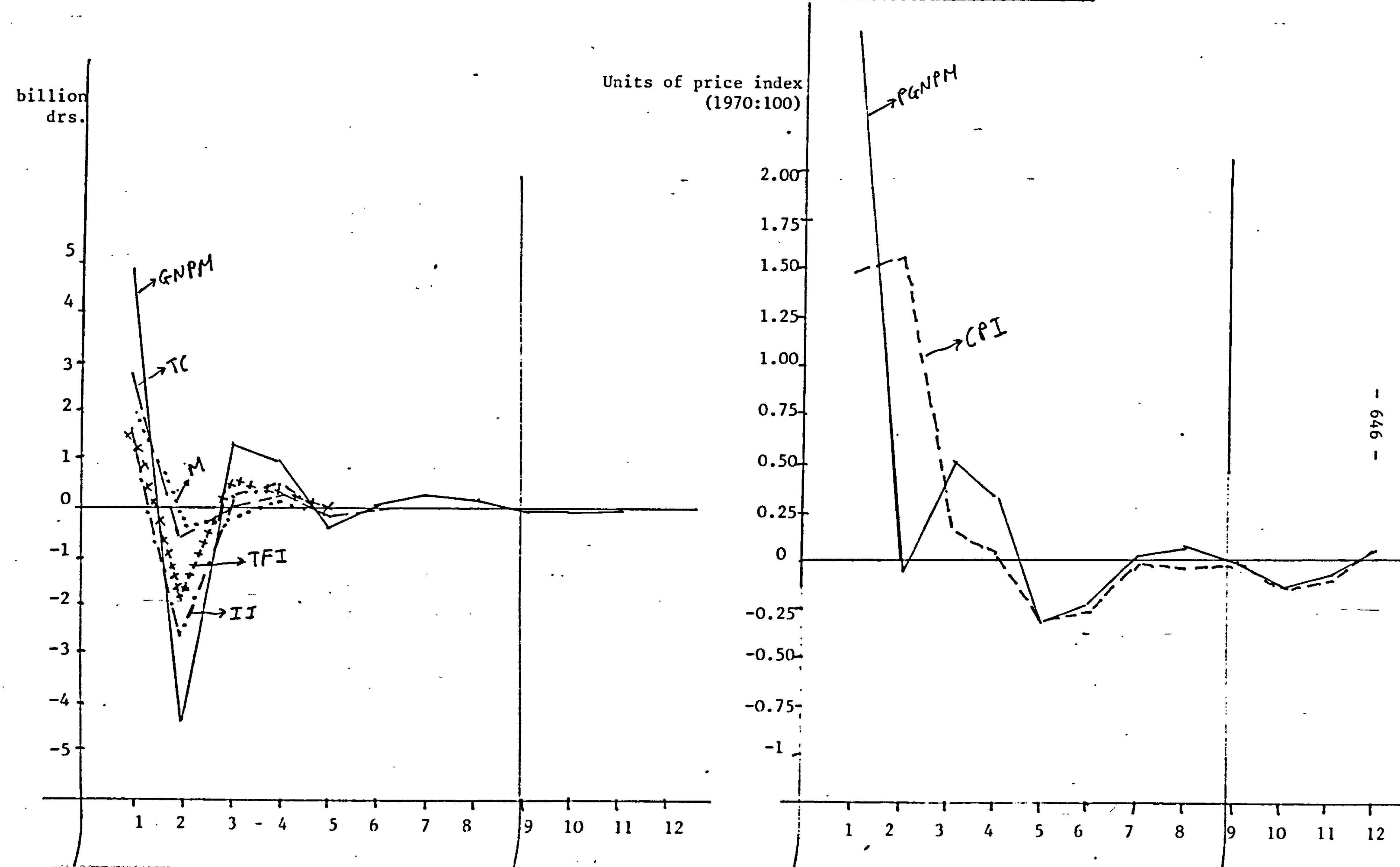
(THE MULTIPLIERS ARE NORMALISED)



CUMULATIVE EFFECT OF DEPRECIATION (NORMALISED) OF THE EXCHANGE RATE



INCREASE IN THE DISCOUNT RATE OF THE BANK OF GREECE BY 1 PERCENTAGE POINT



CUMULATIVE EFFECT OF ONE PERCENTAGE POINT INCREASE IN THE DISCOUNT RATE

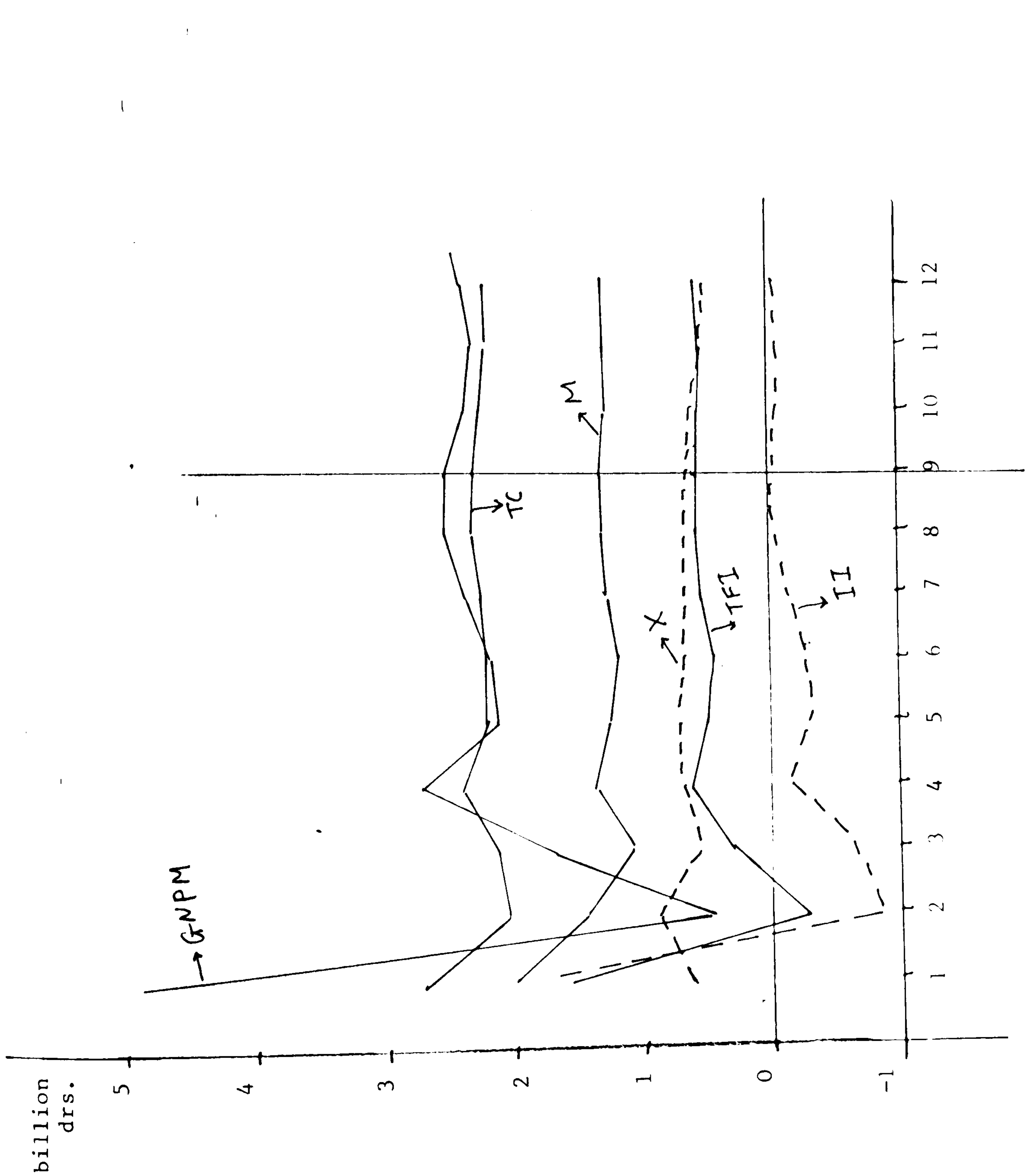


TABLE 18 IDENTITIES

The following identities were used in the model (the trivial ones are not included, such as the ratio of two prices to derive a relative price, or variables created by differencing or by calculating their rate of change). Variables or identities in value terms (designated except otherwise stated, by adding the letter V at the end of the symbol used for that particular variable i.e. TCNDV is the variable TCND in value terms) were derived by multiplying each of them (variables) expressed in real terms by the corresponding price deflator.

Total Domestic Consumption	TC=CND+CD+CS
Total National Consumption	TCN=TC-ENR+ERA
Total National Domestic Consumption	TCND=TC-ENR
Total Fixed Investment	TFI=HI+CI+EI
Total Investment	TI=TFI+II
Total Imports of Goods	MG=M01+M24+M3+M56+M7+M89
Total Imports of Goods and Services	M=MG+PTOS+ERA
Total Exports of Goods and Services	X=XG+RTOS+ENR
GNP at market prices	GNPM=TCN+TI+GCE+X-M+(IR-IP)+DISCR*

*As Discrepancy (DISCR) refers to the whole system no adjustment of the components of GNPM was made. But the figures given in the national accounts for discrepancy were added to the sum of the estimated components of GNPM before comparisons were made.

Cont'd...

TABLE 18 (Continued)

GNP at factor cost	GNP=GNPM-ITV/PGNPM+SUBV/PGNPM
Total Indirect Taxes	ITV=ITND+DUT
Total Direct Taxes	TDT=DT+ECV
Personal Disposable Income	DY=GNP-DEPR-TDT+GTHN+(TR-TP)
Rate of Duty taxes	DUTRT=DUT/MGV
Import Price including the Rate of Duties	PMD=PMG(1+DUTRT)
Productivity	PROD=(GNP-AGPR)/EMPL
Final Expenditure	FE=TCND+TI+X+GCE
Rate of Indirect Taxes	RIT=ITV/FEV

TABLE 19 Coefficients of the Preferred Simultaneous* System with Orthogonal Factors

Dependent Variable	Constant	GTHN	GCE	DIRA	ER	PC1R	PC2M	PC3P	PC4I	D74	ρ
CND	77219.5	-0.3189	1.5989	932.4	-586.7	2052.1	5452.8	-11443.3	-2056.1	-6333.5	0.94
CD	37429.7	0.6659	0.5668	1101.7	-261.1	1056.3	4087.4	-2986.9	-826.7	-5709.9	0.95
CS	43554.1	0.5278	0.8288	673.7	-391.1	465.3	2981.7	-5787.4	-1332.1	-2129.2	0.95
HI	46069.8	0.5895	0.2542	784.5	-1371.5	43.3	4244.4	-5058.4	-2490.2	-10625.5	0.05
CI	19129.7	0.6806	0.2540	-284.8	-530.3	763.1	2093.5	-5199.6	-1710.9	-2585.1	0.74
EI	-90.01	-0.3207	0.8321	1070.9	-368.01	3934.3	3371.1	-7020.5	-2456.6	-5942.9	0.50
II	-14561.5	-3.8322	3.8942	1694.1	-1616.7	-4811.6	11948.5	-31093.1	-10651.7	-5452.5	0.35
XG	-26125.9	-1.1318	1.0945	301.8	824.6	6256.1	5588.7	-5639.8	362.6	-4481.6	0.69
M01	-3.1805	0.3986	0.9052	0.4424	-0.6758	-0.1639	0.1036	-0.3377	-0.1285	-0.0779	0.20
M24	7166.3	-0.0775	0.2070	65.1	-287.7	198.3	1517.3	-2206.6	-566.9	-321.2	0.15
M3	-21149.0	-1.2835	1.1163	54.6	391.8	980.0	2024.6	-5164.8	-704.3	369.4	0.25
M56	11.0356	0.4695	-0.4009	-0.0045	-0.6569	0.2023	0.0618	0.0903	-0.014	-0.1414	-0.25
M7	22241.6	0.6449	-0.0937	223.02	-664.6	2685.4	3843.9	-2098.6	-299.8	-3550.5	0.62
M89	426.7	0.0661	-0.0027	26.7	-11.08	105.01	314.8	-229.1	-94.3	-287.2	0.58
ENR	1.8952	-0.4309	0.8861	0.3106	0.2872	0.2739	0.1040	-0.0655	-0.2008	-0.6366	-0.36
RTOS	1030.1	-0.0940	0.0722	-42.6	52.4	1242.1	-602.6	1025.8	354.8	-1191.2	-0.05
ERA	6414.7	0.0062	0.0950	-0.9583	-238.6	116.9	899.8	-1078.01	-180.5	-711.2	-0.48
PTOS	-16.3318	-0.3387	3.6011	1.1014	-3.3112	-0.4009	0.1913	-0.5182	-0.2656	-0.8578	0.65
IRV	-1701.2	-0.3399	0.6848	630.64	116.7	-3074.6	5294.2	-5412.5	-1429.6	5589.3	0.95
IPV	-14959.0	-0.2532	0.3203	109.5	349.2	98.9	986.5	-1595.6	-341.3	871.3	0.65
ΔDEPR	-5546.0	0.1932	-0.1178	57.3	220.8	410.3	-1280.2	1570.1	354.3	-757.7	0.55
TRV	24630.0	-0.0403	0.3558	836.9	-492.4	-1479.7	3589.9	-3336.5	-1053.6	-1083.2	0.95
TPV	-27.718	-2.9071	4.6497	-1.246	4.3978	0.3592	-0.0293	0.1417	0.1789	0.9911	0.62
AGPR	-23639.4	-1.3483	2.0122	131.2	792.1	-2633.9	-2129.3	-11408.6	-4092.2	-2715.6	-0.02
WR	-16.3601	0.00044	0.0018	1.018	0.2527	-1.1154	17.293	-1.9364	-0.0095	9.068	0.65
CPI	83.376	-0.0018	0.0020	1.486	-0.1504	-4.146	17.073	-0.5692	3.074	16.731	0.90

Cont'd.....

TABLE 19 (Continued)

Dependent Variable	Constant	GTHN	GCE	DIRA	ER	PCIR	PC2M	PC3P	PC4I	D74	ρ
PGNPM	53.217	-0.0024	0.0029	2.720	0.1028	-5.623	19.615	-10.9871	-2.2175	11.059	0.91
PCND	61.4096	-0.0026	0.0029	2.4493	0.2324	-5.387	17.8925	-8.0957	-1.0627	11.589	0.92
PCD	55.6196	-0.0020	0.0025	1.7841	-0.167	-3.6831	15.769	-6.5654	-1.392	11.873	0.80
PCS	44.9115	-0.0015	0.00197	1.2943	0.8847	-3.9456	11.5589	-0.7429	0.5931	10.811	0.90
PHI	78.1138	-0.00073	0.00198	1.5246	-1.169	3.0195	26.587	1.2082	2.8486	25.4331	0.60
PCI	148.554	-0.0003	0.00166	-0.5779	-3.0056	1.0201	26.1476	8.7031	4.6896	32.359	0.09
PEI	2.6733	0.0986	-0.219	-0.1092	1.0019	0.1088	0.05776	0.1741	0.05406	0.03175	0.40
PII	-331.53	-0.0158	0.0165	18.60	1.573	-55.491	-16.662	-52.43	-67.498	-10.369	-0.30
PMG	-97.179	-0.0070	0.007	1.3266	3.4375	-7.024	16.3949	-19.006	-0.8648	18.091	0.55
PMS	78.5426	-0.0017	0.0021	-1.9204	0.4949	-0.1078	14.5889	6.7684	7.5643	20.845	0.30
PXG	132.965	-0.0055	0.00396	4.2723	-1.5514	-8.129	21.638	-9.6079	-1.8245	14.575	0.91
PXS	-93.919	-0.008	0.0079	1.302	2.9858	-7.598	22.745	-29.635	-3.7812	14.549	0.44
RL	3.9998	-0.00005	0.00010	0.4156	-0.041	0.4061	-0.5296	0.0439	0.1687	0.3452	0.20
RD	4.7259	-0.00041	0.00046	0.7569	-0.3866	-1.5247	-0.777	-1.5672	-1.0807	-0.129	0.43
ΔDEP	-97948.9	1.0882	-0.0794	37.9775	3220.8	200.43	-2428.9	9908.5	3387.8	-4554.5	0.76
ΔLO	-82144.9	-2.207	3.1999	4105.6	291.3	-7632.8	6649.4	-11932.9	-11212.1	-7297.3	-0.11
CUR	42514.4	0.0539	1.6678	1347.4	-1054.5	-2999.4	18245.4	-5858.7	124.63	9832.9	0.93
ITND	-19276.2	0.5015	0.9154	-320.8	498.9	-1592.1	10704.2	616.87	487.68	4692.95	-0.001
DUT	2030.86	-0.1872	0.4191	335.45	-147.01	1241.05	3893.1	-1643.92	128.08	-1554.3	0.65
SUBV	-10784.5	-0.2326	0.5253	384.72	27.49	-1547.7	4259.35	-2865.9	-620.88	4115.7	0.77
NWYV	62383.0	-8.7424	8.8223	9415.3	1274.01	-7402.6	58773.2	-65070.7	-15607.1	109.85	0.95
EMPL	6.7531	0.0626	-0.0353	0.0466	0.0765	0.0163	0.0087	0.01925	-0.00039	-0.0106	0.93
UN	12.8785	2.1359	-2.9047	-1.2238	0.8715	-0.2026	-0.1852	0.3132	0.5061	0.7875	-0.24
DT	-101348.0	-0.256	0.8029	1095.8	3601.97	-1034.9	6958.0	-7875.2	-2045.6	10024.3	0.95
ECV	-13370.9	0.2637	0.2005	123.08	348.3	-357.54	3880.2	-523.05	-21.34	2482.4	0.50

Cont'd.......

*From the above equations those concerning the dependent variables M01, M56, ENR, PTOS, TPV, PEI, EMPL, UN have been estimated in logarithmic form (in which the corresponding structural equations are).
In the simultaneous system with oblique factors no consistent pattern of differences, compared with the above estimates, appeared, although there were differences in signs and magnitudes.

In the blockwise estimation, whether orthogonal or oblique factors were employed, the following pattern of differences appeared: a) in the first block equations (prices) the coefficient of the first principal component (PC1R) was positive while that of the third component (PC3P) had a substantially larger magnitude, b) in the second block (financial variables) the coefficient of discount rate (DIRA) had a negative sign for the functions of deposits, loans and money.

APPENDIX 4

VARIABLES EMPLOYED IN THE ESTIMATED EQUATIONS

AGPR	=	Agricultural production at constant 1970 prices.
BOR	=	Borrowing requirements at current prices (net transfer of capital is not included).
CD	=	Consumption of durables at constant 1970 prices
CEI	=	Construction and equipment investment at constant 1970 prices.
CI	=	Construction investment at constant 1970 prices.
CND	=	Consumption of non-durables at constant 1970 prices.
CNDV	=	Consumption of non-durables at nominal value.
CPI	=	Consumer price index base year 1970:100.
CS	=	Consumption of services at constant 1970 prices.
CUR	=	Currency in circulation, nominal value.
CV	=	Total consumption , nominal value.
D74	=	Dummy variable for the oil price increase in 1974.
DEF	=	Deficit of international transactions at current prices.
DEP	=	Total deposits, nominal value.
DEPR	=	Depreciation at constant 1970 prices.
DIRA	=	Bank of Greece Discount rate.
DISCR	=	Discrepancy at constant 1970 prices.
DP	=	Demand Pressure at constant 1970 prices.
DT	=	Direct taxes, nominal value.
DUT	=	Duty taxes, nominal value.
DUTRT	=	Duty rate.
DY	=	Personal Disposable Income at constant 1970 prices.
EI	=	Equipment Investment at constant 1970 prices.
ECV	=	Employers contribution to social security, nominal value.
EMPL	=	Employment of salary and wage earners,in thousands.

ENR = Expenditure of non-residents in Greece at constant 1970 prices.

ER = Exchange rate (drachmae per U.S. dollar).

ERA = Expenditure of residents abroad at constant 1970 prices.

FE = Final expenditure at constant 1970 prices.

FEV = Final expenditure, nominal value.

GCE = Government's current expenditure on goods and services at constant 1970 prices.

GNP = Gross National Product at factor cost at constant 1970 prices.

GNPM = Gross National Product at market prices at constant 1970 prices.

GNPV = Gross National Product at factor cost, nominal value.

GTHN = Governments transfers to households net at constant 1970 prices.

HI = Investment in Housing at constant 1970 prices.

HIV = Investment in Housing, nominal value.

II = Inventory investment at constant 1970 prices.

IIP = Index of industrial Production base year 1970:100.

IP = Income payments to the rest of the world, at constant 1970 prices.

IR = Income receipts from the rest of the world, at constant 1970 prices.

ITND = Indirect taxes (excluding duties), nominal value.

ITV = Total Indirect Taxes, nominal value.

LAV = Liquid Assets, nominal value.

LOAN = Total Bank Loans, nominal value.

ΔLO = First differences in total bank loans, nominal value.

M01 = Imports of SITC categories 0 and 1. Foodstuffs and live animals (0), Beverages and tobacco (1) at constant 1970 prices.

M24 = Imports of SITC categories 2 and 4. Raw materials, excluding fuels (2), Oils and fats (4) at constant 1970 prices.

M3	=	Imports of SITC categories 3, Fuels and lubricants (3) at constant 1970 prices.
M56	=	Imports of SITC categories 5 and 6. Chemicals (5), Manufactured goods classified according to raw materials (6), at constant 1970 prices.
M7	=	Imports of SITC categories 7. Machinery and transport materials (excluding ships) at constant 1970 prices.
M89	=	Imports of SITC categories 8 and 9. Various manufactured goods (8) and various non classified goods (9), at constant 1970 prices.
M	=	Total Imports of goods and services at constant 1970 prices.
MG	=	Total Imports of goods at constant 1970 prices.
MGV	=	Total imports of goods, nominal value.
MS	=	Total Imports of Services at constant 1970 prices.
MXG	=	Total Imports and Exports of goods at constant 1970 prices.
NWYV	=	Non-Wage Income, nominal value.
PC	=	Weighted Consumer price index in U.S. dollars of four competitor countries for tourists baseyear 1970:100.
PC1R	=	Principal Component on real variables.
PC2M	=	Principal Component on nominal variables
PC3P	=	Principal Component on prices
PC4I	=	Principal Component on interest rates.
PCD	=	Implicit deflator of consumption of durables base year 1970:100.
PCI	=	Implicit deflator of construction investment base year 1970:100.
PCND	=	Implicit deflator of consumption of non-durables base year 1970:100.
PCS	=	Implicit deflator of consumption of services base year 1970:100.
PEI	=	Implicit deflator of equipment investment base year 1970:100.
PG	=	Greece's consumer price index in U.S. dollars base year 1970:100.
PGNPM	=	Implicit deflator of GNP at market prices base year 1970:100

PHI = Implicit deflator of Housing Investment base year 1970:100.

PII = Implicit deflator of inventory investment base year 1970:100.

PMD = Unit value index of import of goods, including duty taxes base year 1970:100.

PMG = Unit value index of import of goods, base year 1970:100.

PMS = Implicit deflator of import of services base year 1970:100.

PROD = Productivity, in thousand drs. at constant 1970 prices.

PT_1 = Weighted consumer price index in U.S. dollars for the main countries from which tourists come to Greece.

PT_2 = Weighted consumer price index in U.S. dollars of the same countries as in PT_1 from which tourists travel to Greece's competitor countries.

PTOS = Payments for transport and other services at constant 1970 prices.

PX = Unit value index of exports in U.S. dollars, base year 1970:100.

PXG = Unit value index of exports, base year 1970:100.

PXS = Implicit deflator of export of services, base year 1970:100.

PWX = Unit value index of world exports of goods in U.S. dollars, base year 1970:100.

PWXG = Unit value index of world exports of goods in drs, base year 1970:100.

RD = Interest rate on saving deposits.

RIT = Rate of indirect taxes.

RL = Interest rate on long term loans to industry.

RTOS = Receipts from transport and other services at constant 1970 prices.

SUBV = Subsidies, nominal value.

T = Time trend.

TC = Total consumption expenditure at constant 1970 prices.

TCN = Total national consumption expenditure at constant 1970 prices.

TCND = Total national domestic consumption expenditure at constant 1970 prices.

TDT = Total direct taxes, nominal value.

TEMIS = Total employment in industry and other activities, in thousands.

TFI = Total fixed investment at constant 1970 prices.

TI = Total investment at constant 1970 prices.

TP = Transfer payment to the rest of the world, at constant 1970 prices.

TR = Transfer receipts from the rest of the world, at constant 1970 prices.

UN = Unemployment in thousands.

WR = Average wage in thousand drs. per year.

WY = World export of goods in million U.S. dollars at constant 1970 prices. WYV is expressed in billion U.S. dollars in the tables.

WIV = Total wages and salaries, nominal value.

X = Total exports of goods and services at constant 1970 prices.

XG = Total exports of goods at constant 1970 prices.

XS = Total export of services at constant 1970 prices.

The above variables, whether at constant prices or in nominal terms, are expressed in million drachmae, except otherwise stated. (Variables in nominal terms have the same symbol with those in real terms and followed by the letter V e.g. IRV is the symbol for the nominal income receipts (IR) from the rest of the world.)

The data for the above variables were taken from sereral issues of the following:

- Statistical Yearbook of Greece.
- National Accounts of Greece.
- Monthly Statistical Bulletin (National Statistical Service of Greece).
- Bank of Greece: Monthly Statistical Bulletin.
- Monthly Bulletin of External Trade (National Statistical Service of Greece).

- United Nations: Statistical Yearbook.
- United Nations: National Accounts.
- United Nations: Monthly Statistical Bulletin.
- United Nations: Yearbook of International Trade Statistics.
- OECD: National Accounts.
- OECD: Revenue Statistics.
- OECD: Labour Force Statistics.
- International Labour Office: Yearbook of Labour Statistics.
- Eurostat: National Accounts.
- International Monetary Fund: Financial Statistics.

DATA TABLES*

Year	GNPM	GNPV	GNP	TC	II	TFI	X
1954	102756	57467	95000	82722	-1145	14389	7326
1955	110518	65859	101478	88640	821	15944	8744
1956	120394	76761	110751	93094	1711	19395	8404
1957	128690	82348	117837	98799	3665	19120	9871
1958	134086	85162	121995	102189	1337	24169	10436
1959	139044	88650	126897	105234	-1645	25264	10838
1960	145458	95174	131272	108744	-814	29121	10830
1961	161802	107305	146200	116529	3072	31476	12402
1962	164674	113508	147468	121826	769	34128	13641
1963	181534	126409	162485	128463	3354	35996	14545
1964	196586	142021	174825	138954	7103	43445	14787
1965	214922	161586	190871	149849	8837	49003	16662
1966	228040	178708	201118	160958	2615	50567	22395
1967	240791	192731	210760	170287	4572	49770	23525
1968	257226	207674	223172	181475	-243	60397	23288
1969	282168	234027	243478	193291	3742	71653	26690
1970	304420	263503	263503	209955	13346	70663	29938
1971	327723	295299	286076	223860	8715	80558	33549
1972	356886	339554	312228	240015	6487	92977	41217
1973	378904	434474	333810	259325	21498	100093	50847
1974	369325	525196	332085	257586	22550	74500	48157
1975	390000	612338	347471	274101	21100	74660	52877
1976	415491	753677	369211	292075	19400	79750	61119
1977	431164	874907	381564	307499	16700	85950	62489
1978	458663	1049200	404685	324841	15660	91088	75067
1979	475978	1288600	419792	332851	18099	99045	81049
1980	482973	1577400	431101	333476	18658	89765	84803
1981	479376	1911800	435689	335901	11713	82027	87147
1982	474514	2317600	420999	353800	16633	81248	74433

* At the end of the data tables the construction of the variables, with number superscripts, is explained.

Year	M	DY[1]	GCE	DISCR	MG	XG	MXG	WY	WYV
1954	10668	73870	12211	-4255	9915	5360	15275	89769	79
1955	12125	80154	12580	-6625	11214	5834	17048	97501	86
1956	14040	91205	14459	-6897	12777	5587	18364	106154	96
1957	15732	94484	14298	-5871	14324	6723	21047	111906	103
1958	18203	96730	15014	-5870	16442	7244	23686	109757	98
1959	16672	105584	15993	-3857	14773	6963	21736	117485	103
1960	19064	110093	16721	-4997	16756	7129	23885	129686	117
1961	21486	122652	17896	-2643	19044	7702	26746	136019	121
1962	23658	130122	18697	-5942	20605	8379	28984	143427	128
1963	27297	142592	20025	-1721	24245	8617	32862	154311	139
1964	31461	157440	22420	-4133	27024	9256	36280	169924	156
1965	38122	175191	24708	-1359	33205	10035	43240	181663	169
1966	37943	184219	26422	-1499	35311	12060	47371	196137	184
1967	40653	195893	30710	-1200	35817	15006	50823	207078	193
1968	44857	207513	32465	1233	38755	14467	53222	233860	215
1969	51803	233288	35210	882	43903	17123	61026	260300	247
1970	54996	249548	37742	-3633	46616	19275	65891	279800	280
1971	59198	272067	40079	- 240	50155	19873	70028	299600	318
1972	68322	299382	42344	2107	58004	25120	83124	325400	371
1973	90359	335245	42814	-7954	72280	32433	104713	365600	519
1974	75139	304353	49537	-12331	65521	34402	99923	384500	765
1975	79915	316149	57534	-10279	64241	37652	101893	369800	791
1976	84868	336301	60798	-10903	67723	43893	113616	412300	899
1977	91465	348787	66742	-12567	74403	43331	117734	429409	1018
1978	98269	368614	71129	-18818	77281	49492	126773	499538	1298
1979	104395	377069	75503	-19169	83837	52072	135909	535212	1643
1980	97001	361537	76787	-10400	77279	57560	134839	543133	1993
1981	101885	354145	83455	-51652	78115	56519	134634	551173	1973
1982	104847	357866	84378	-65393	89155	50264	139419	537304	1854

Year	ER[2]	DIRA[3]	PWXG	PXG	PXS	PMG	PMS	UN
1954	30.00	11.00	88	85	85	98	98	-
1955	30.00	11.00	88	94	94	99	99	-
1956	30.00	11.00	90	102	100	103	85	38
1957	30.00	11.00	92	98	104	105	95	87
1958	30.00	11.00	89	96	95	96	89	79
1959	30.00	10.00	88	88	93	96	87	89
1960	30.00	7.00	90	86	94	93	86	87
1961	30.00	6.00	89	87	92	91	87	76
1962	30.00	6.00	89	89	91	91	83	75
1963	30.00	5.50	90	101	91	91	105	70
1964	30.00	5.50	92	100	94	93	110	65
1965	30.00	5.50	93	98	95	95	100	64
1966	30.00	5.50	94	101	100	96	137	65
1967	30.00	5.00	93	99	96	95	103	84
1968	30.00	5.00	92	97	96	96	97	74
1969	30.00	6.00	95	97	97	96	97	67
1970	30.00	6.50	100	100	100	100	100	49
1971	30.00	6.50	106	100	104	103	102	30
1972	30.00	6.50	114	104	113	113	110	24
1973	29.54	8.00	139	132	142	135	136	21
1974	30.00	10.00	199	177	196	196	169	27
1975	32.41	8.50	232	197	234	233	197	35
1976	36.89	10.00	268	215	262	260	210	28
1977	37.20	11.00	294	237	273	272	237	28
1978	36.74	12.50	320	250	304	302	251	31
1979	37.04	16.00	379	277	364	362	279	32
1980	42.62	19.75	521	389	488	491	367	37
1981	55.41	20.50	661	422	575	573	382	43
1982	66.80	20.50	768	569	729	710	513	50

Year	CPI	PGNPM	FEV[4]	ITV	DEPR	SUBV	ECV	RIT[5]	PG/PT_1[6]
1954	73	62	72621	6020	5136	202	1031	8.29	1.09
1955	78	66	85440	7196	5124	77	1376	8.42	1.15
1956	80	70	98926	8293	5225	432	1534	8.38	1.16
1957	83	71	106632	9232	5662	202	1715	8.66	1.19
1958	84	71	113310	10479	6085	390	1796	9.25	1.17
1959	80	71	115603	10985	6826	660	2035	9.50	1.08
1960	82	74	125224	12082	7230	140	2300	9.65	1.09
1961	83	75	138231	14118	7680	402	2654	10.21	1.06
1962	83	78	148658	15516	8609	418	3193	10.44	1.06
1963	85	79	163624	17972	9254	725	3518	10.98	1.05
1964	86	82	188492	20715	9907	1387	4177	10.99	1.04
1965	89	85	213955	23805	10702	1996	4839	11.13	1.03
1966	93	89	231081	28458	11727	3280	5718	12.31	1.06
1967	94	92	254039	31616	12751	3935	6442	12.45	1.07
1968	95	93	273909	35242	13857	3366	7220	12.87	1.04
1969	95	96	311243	39819	14917	2426	8027	12.79	1.01
1970	100	100	355785	43406	16860	2489	8965	12.20	1.00
1971	103	103	388823	46833	19026	3955	10015	12.05	0.93
1972	107	109	445893	52526	21878	4777	11938	11.78	0.92
1973	124	129	592992	64826	23603	8891	14356	10.93	0.97
1974	158	158	706214	71562	24926	14685	16936	10.13	1.03
1975	179	177	841425	95961	26766	16984	21063	11.41	1.00
1976	202	205	1019760	119254	28949	23057	28924	11.69	0.93
1977	228	231	1204683	147600	31423	28500	35812	12.25	0.92
1978	257	260	1483050	178219	34515	33536	45282	12.02	0.94
1979	306	309	1805930	216700	36339	33100	53486	12.00	0.97
1980	382	366	2140400	228800	38768	39000	72400	10.70	0.86
1981	476	439	2628500	277700	39590	86000	91200	10.57	0.89
1982	576	551	3182000	378800	38621	84200	116000	11.90	-

Year	PC/PT_2[6]	XS	MS	RL[3]	RD[3]	CUR[7]	DEP[7]	LOAN[7]
1954	0.84	1966	753	10.00	7.00	-	-	-
1955	0.84	2910	911	9.00	7.00	6923	1595	11043
1956	1.00	2817	1263	10.00	9.50	8155	2490	13105
1957	0.92	3148	1408	10.00	8.50	9467	4821	16775
1958	0.96	3192	1761	10.00	7.50	10752	7612	20615
1959	0.90	3875	1899	8.50	6.50	12138	10297	23639
1960	0.91	3701	2308	7.00	5.00	14288	13137	27099
1961	0.90	4700	2442	7.00	4.75	16679	15929	30935
1962	0.92	5162	3053	7.00	4.75	19167	19928	35291
1963	0.96	5928	3052	7.00	4.75	22059	25578	41673
1964	0.99	5531	4437	7.00	4.75	25898	30470	49016
1965	1.01	6627	4917	7.00	4.75	30258	33857	55948
1966	1.03	10335	2632	7.50	5.25	34097	39419	63991
1967	1.01	8519	4836	7.50	5.25	39638	45444	74075
1968	1.01	8821	6102	7.50	5.25	44329	54866	85628
1969	1.00	9567	7900	7.50	5.25	47106	68919	101413
1970	1.00	10712	8380	7.50	5.25	51649	84804	122697
1971	0.96	13676	9043	7.50	5.25	58062	106382	148603
1972	1.04	16097	10048	7.50	5.25	68927	133144	180983
1973	1.07	18414	18079	8.50	6.50	84597	155206	218437
1974	1.04	13755	9618	10.50	9.50	102306	179731	262005
1975	1.12	15225	15674	10.50	9.00	120181	228564	320039
1976	1.03	17226	15145	10.50	7.50	144444	295752	398055
1977	1.00	19158	17242	10.50	7.50	173520	373937	495153
1978	0.99	25575	20988	11.00	7.75	207811	473323	606465
1979	1.06	28977	20558	13.00	10.90	246517	581265	730785
1980	1.06	27243	19722	16.75	13.50	288753	714412	889223
1981	1.05	30628	23770	18.00	13.50	347232	948331	1130319
1982	-	24169	15692	-	-	-	-	-

Years	AGPR	CND[8]	CD[8]	CS[8]	HI	CI	EI	M01	M24
1954	27179	49811	8614	24297	6095	4651	3643	1664	1486
1955	29078	52291	10106	26243	7045	4702	4197	2390	1453
1956	29851	54356	10643	27915	7818	6181	5396	2821	1793
1957	33738	57347	11926	29526	6911	6900	5309	2759	2051
1958	31413	57976	14528	29685	8352	8267	7550	2798	1966
1959	32947	59465	14547	31222	7857	10472	6935	2406	1600
1960	29863	60469	15820	32455	8506	13211	7404	2433	2143
1961	37836	64909	17395	34225	9132	14342	8002	2921	2369
1962	32883	66456	19124	36246	10391	14707	9030	2616	2313
1963	39594	69582	20384	38497	11287	15319	9390	3503	2891
1964	39446	73557	23847	41550	13712	17253	12480	4056	5875
1965	43377	79534	26417	43898	15482	19181	14340	5069	3939
1966	43687	84975	28222	47761	15642	19056	15869	5154	4254
1967	44311	89973	29016	51298	13956	19358	16456	5369	3866
1968	40484	93726	32199	55550	19445	23165	17787	5308	4193
1969	43085	99134	34474	59683	23212	25451	22990	5751	5005
1970	47058	103490	41796	64669	19740	25748	25175	5746	5341
1971	48662	107793	45777	70290	23641	29928	26989	6931	5323
1972	51543	113088	50979	75948	29964	33611	29402	6349	5498
1973	51204	122005	57043	80277	30576	34377	35140	8876	7426
1974	53672	121899	55028	80659	15869	27457	31174	7167	6561
1975	56733	127580	62323	84198	20476	26180	28004	6651	6034
1976	55971	132660	69387	90028	21909	27336	30505	6657	6135
1977	51830	135684	76302	95513	26428	28091	31431	7408	6863
1978	57214	149215	76848	98778	30074	27541	33485	9253	6035
1979	53616	152368	76147	104307	31572	28654	38044	9085	6301
1980	59621	155698	68955	108823	27290	24284	38156	8367	5803

Year	M3	M56	M7	M89	PCND	PCD	PCS	PHI
1954	1390	3272	1733	370	63	72	62	56
1955	1575	3378	2057	361	65	76	67	61
1956	1547	3787	2427	402	71	82	71	64
1957	1905	4374	2842	393	72	82	72	65
1958	1915	5299	4004	460	74	82	73	67
1959	1546	4985	3734	502	75	86	75	68
1960	1692	5769	4156	563	77	86	78	68
1961	1699	6387	5052	616	77	86	79	68
1962	1687	7058	6215	716	78	85	81	73
1963	2319	7686	7004	842	82	86	83	73
1964	1987	8558	8544	1004	84	87	84	74
1965	3015	10060	9985	1137	89	89	87	78
1966	2822	10609	11186	1286	93	93	89	87
1967	2973	10786	11438	1385	94	96	91	88
1968	3141	11057	13609	1447	94	96	93	88
1969	3706	12573	15198	1490	98	97	96	91
1970	4040	13957	15802	1729	100	100	100	100
1971	4469	14891	16715	1826	104	101	102	100
1972	6137	17746	20236	2038	109	104	105	109
1973	9404	20391	23914	2269	128	119	117	136
1974	14914	17910	17285	1684	159	146	143	175
1975	16343	16621	16768	1824	181	161	164	185
1976	17504	17658	19430	2339	206	181	185	217
1977	14240	19590	23447	2855	230	205	208	262
1978	17325	20340	21107	3122	256	231	236	322
1979	20936	21146	23026	3396	301	271	278	415
1980	19298	19476	21207	3128	368	332	339	504

Year	PCI	PEI	PROD[9]	WR[10]	TEMIS	EMPL[11]	RTOS	ENR	PTOS
1954	55	65	69	16	1282	979	732	1234	279
1955	58	64	72	18	1314	1003	1122	1788	394
1956	60	61	79	21	1347	1028	1025	1792	640
1957	61	65	80	21	1380	1053	1056	2062	655
1958	64	66	84	24	1415	1080	1173	2019	1003
1959	65	72	85	25	1442	1101	1720	2155	1040
1960	65	76	90	27	1469	1122	1131	2570	1259
1961	65	76	95	29	1497	1144	1793	2907	1394
1962	69	85	96	30	1568	1198	1952	3310	1869
1963	69	88	100	32	1604	1226	1921	4007	1959
1964	70	88	111	38	1617	1221	2037	3494	2800
1965	73	88	117	42	1649	1261	2433	4194	2976
1966	81	91	122	47	1691	1293	4849	5486	1280
1967	84	94	127	51	1720	1315	3160	5359	2647
1968	87	96	137	56	1748	1336	3445	5376	3658
1969	90	95	146	61	1799	1375	3587	5980	4476
1970	100	100	153	66	1855	1418	3678	7034	5496
1971	100	111	162	71	1921	1468	3696	9980	5992
1972	107	124	173	80	1974	1509	4387	11710	6256
1973	133	138	184	93	2043	1562	5440	12974	14386
1974	171	163	175	111	2085	1594	4991	8764	6301
1975	184	192	179	134	2126	1625	5775	9450	12281
1976	206	223	186	164	2148	1642	4918	12308	11548
1977	258	254	190	200	2178	1665	5027	14121	13428
1978	308	288	196	251	2227	1702	6169	17212	16122
1979	389	325	201	305	2292	1752	7343	18104	15368
1980	477	385	206	355	-	-	-	-	-

Year	ERA	ITND	DUT	IIP	DP[12]	NWYV[13]	IRV	IPV
1954	474	3783	2237	33.0	17212	35858	975	102
1955	517	4254	2942	34.1	19009	41179	1103	165
1956	623	4668	3625	34.6	19962	46589	1599	78
1957	723	5169	4063	37.0	18170	50319	2166	77
1958	758	6101	4378	41.0	22422	53171	1601	142
1959	859	7588	3397	41.5	22093	54010	1726	190
1960	1049	8474	3608	44.8	24874	56995	2213	264
1961	1048	10146	3972	47.7	21056	65568	2806	422
1962	1184	11183	4333	49.9	28831	67426	3045	444
1963	1093	13229	4743	53.6	22223	76535	3467	525
1964	1637	15458	5257	59.5	28491	85421	4234	884
1965	1941	17803	6002	63.8	30646	96808	4388	758
1966	1352	21168	7290	73.5	36827	104859	4944	1046
1967	2189	23674	7942	75.6	37280	110181	5613	1298
1968	2449	26922	8320	81.0	43866	115336	6484	1442
1969	3424	30487	9332	90.2	41179	131004	6757	1725
1970	2884	33195	10211	100.0	45283	147867	7777	2274
1971	3051	35933	10900	110.0	50724	165921	10774	2897
1972	3792	39231	13295	126.9	59731	188029	13027	3450
1973	3693	47343	17483	147.0	71798	256276	17604	4519
1974	3317	53521	18041	144.2	64147	295171	24744	6876
1975	3393	73751	22210	150.5	67647	331601	26761	7554
1976	3597	92859	26395	166.4	74564	402614	34906	9964
1977	3819	116836	30764	169.0	86503	439185	40602	10323
1978	4619	140456	37754	-	-	515178	44701	12260
1979	4827	178958	37732	-	-	621988	59558	16097
1980	-	-	-	-	-	763157	79804	22701

Years	TRV	TPV	GTHN	WIV[14]	PII	DT	TDT	DEF[15]	BOR[16]
1954	1434	28	3542	15682	98	3351	4382	3356	1950
1955	2033	25	4006	18170	118	3725	5101	2844	836
1956	2211	74	4484	21924	122	4347	5881	4202	2065
1957	2583	74	4825	22350	98	4927	6642	4421	1912
1958	2709	28	5424	25778	97	5030	6826	5915	3234
1959	2898	26	6063	27582	78	5010	7045	4544	1672
1960	3039	33	6291	30484	54	5442	7742	6014	3008
1961	3489	43	7164	33163	68	6497	9151	6056	2610
1962	4519	66	8696	36190	184	7261	10454	6424	3485
1963	5257	70	10134	39691	88	8169	11687	8226	1525
1964	5481	118	11508	45811	104	9572	13749	12194	6831
1965	6368	127	13773	52610	96	10197	15036	16724	10483
1966	7134	115	15251	60415	49	12384	18102	11087	4068
1967	7040	130	17839	67241	96	14149	20591	11644	4734
1968	7181	125	19818	75051	65	16299	23519	15565	8509
1969	8319	135	21624	84195	92	18663	26690	18863	10679
1970	10337	134	22841	93913	100	21174	30139	19505	9302
1971	14090	131	24657	104392	103	24776	34791	18924	4965
1972	17259	133	25627	120549	105	28086	40024	21846	4720
1973	21782	153	25256	145548	143	33622	47978	40106	18477
1974	21654	1329	24471	177373	177	47087	64023	38962	18637
1975	24821	1479	26791	217793	196	49259	70322	51540	28198
1976	29036	1634	30428	276599	230	75092	104016	48589	21187
1977	33727	1450	34768	346534	256	82368	118180	58055	25778
1978	35796	2121	40734	432740	276	105468	150750	59936	26236
1979	42826	1653	40948	534013	338	134144	187630	82244	41064
1980	45736	1988	-	643340	395	186400	258800	86340	41720
1981	-	-	-	796100	604	228300	319500	98172	40313
1982	-	-	-	1013500	590	-	-	-	-

1. Personal Disposable income is calculated as:
DYV = GNPV - DEPRV - DTV + G + GTHNV + (TRV-TPV). It was then divided by CPI to derive disposable income at constant prices.

2. For some years after 1970 import and export value of ER is given. The figure used in the data is a weighted average of the import and export value; the weights were the corresponding figures for the imports and exports of goods and services.

3. The data for DIRA, RL and RD are weighted averages of the original data. Interest rates had changed more than once for some years. Thus the number of months for which the particular values of interest rates were applied, were used as weights to derive the figures given in the above tables.

4. The value of final expenditure (FEV) was calculated as FEV = TCNDV + TIV + XV + GCEV.

5. The rate of indirect taxes (RIT) was calculated as RIT = ITV/FEV.

6. The construction of the relative prices PG/PT_1 and PC/PT_2 is described in detail in the chapter of international transactions.

7. The figures for CUR, LOAN and DEP are given at the end of the year. Thus the values of these variables in the above tables are mid year estimates calculated as the average of two successive years.

8. The figures for CND, CD and CS for 1954-1957 are not strictly comparable with those from 1958 onwards, as the consumption expenditure has not been broken down into the above mentioned categories for these years, and the attempted classification is not sufficiently accurate, because of the lack of relevant information.

9. Productivity is calculated as
PROD = (GNP - AGPR)/EMPL

10. The average wage per year is WR = WIV/EMPL

11. The construction of the data for EMPL is described in detail in the chapter for Employment.

12. Demand Pressure (DP) is calculated as:
DP = TC + TFI + GCE +X - GDP at market prices.

13. Non wage income (NWYU) includes: Income from Agriculture, Income from property and entrepreneurship accruing to households, corporation savings (including the public ones), and direct taxes on corporations.

14. WIV includes wages and salaries of all sectors excluding those from agricultural sector. Compensation of employees from abroad is also excluded.

15. DEF = XV + IRV - MV - IPV

16. BOR = DEF - (TRV - TPV). Net capital transfers are also excluded.

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